PROCEEDINGS

OF

THE AMERICAN ASSOCIATION

FOR THE

ADVANCEMENT OF SCIENCE

FOR THE FORTY-FIFTH MEETING

HELD AT

BUFFALO, N. Y.

AUGUST, 1896.

SALEM:
PUBLISHED BY THE PERMANENT SECRETARY.
JANUARY, 1897.

EDITED BY

FREDERIC W. PUTNAM.

Permanent Secretary.

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OF THE

BUFFALO MEETING.

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EDWARD D. COPE of Philadelphia.

VICE PRESIDENTS.

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D. Mechanical Science and Engineering—FRANK O. MARVIN of Lawrence, Kans.
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G. Botany—N. L. BRITTON of New York, N. Y.
H. Anthropology—ALICE C. FLETCHER of Washington, D. C.
I. Social and Economic Science—WILLIAM R. LAZENBY of Columbus, Ohio.

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From the Association at Large.—To hold over until successors are elected. A fellow elected from each section.—E. W. HYDE of Cincinnati (**A**); EDWARD L. NICHOLS of Ithaca, N. Y. (**B**); E. A. DE SCHWEINITZ of Washington (**C**); THOMAS GRAY of Terre Haute (**D**); ARTHUR HOLLICK of New York (**E**); C. L. MARLATT of Washington (**F**); L. M. UNDERWOOD of New York (**G**); FRANZ BOAS, New York (**H**); W. H. HALE of Brooklyn (**I**).

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1. *Auditors.*

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2. *Committee on Indexing Chemical Literature.*

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3. *Committee on the Association Table in Biological Laboratory at Woods Holl.*

VICE PRESIDENTS OF SECTIONS F and G, and C. O. WHITMAN, Chicago.

4. *Committee on the Policy of the Association.*

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5. *Committee on Standards of Measurements.*

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6. *Committee on Standard Colors and Standard Nomenclature of Colors.*

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7. *Committee on the Association Library.*

ALFRED SPRINGER, *Chairman*, A. W. BUTLER, W. L. DUDLEY, T. H. NORTON, THOS. FRENCH, JR.

8. *Committee for the study of the White Race in America.*

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9. *Committee to coöperate with the National Educational Association regarding the Teaching of Science in the Secondary Schools.*

R. S. TARR, *Chairman*, H. S. CARHART, A. S. PACKARD, C. F. MABERRY, C. E. BESSEY.

10. *To represent the Association as Member of the American Advisory Board on an International Code of Zoölogical Nomenclature.*

A. S. PACKARD.

11. *Delegates to the International Geological Congress in St. Petersburg in 1897.*

EDWARD D. COPE, JAMES HALL, B. K. EMERSON, W. N. RICE, C. D. WALCOTT
With power to fill any vacancy.

[1] All Committees are expected to present their reports to the COUNCIL not later than the third day of the meeting. Committees sending their reports to the Permanent Secretary one month before a meeting can have them printed for use at the meeting.

LOCAL COMMITTEES

FOR THE

BUFFALO MEETING.

GENERAL COMMITTEE OF ARRANGEMENTS.

HON. EDGAR B. JEWETT, *Chairman.*
EBEN PEARSON DORR, *Secretary.*
And others as given on page 31 of Daily Programme.

EXECUTIVE COMMITTEE.

HON. EDGAR B. JEWETT, *Chairman.*
EBEN PEARSON DORR, *Secretary.*
And others as given on page 32 of Daily Programme.

FINANCE COMMITTEE.

DR. LEE H. SMITH, *Chairman.*
WILLIAM C. CORNWELL, *Treasurer,*
And others as given on page 33 of Daily Programme.

COMMITTEE ON PRINTING.

OTTOMAR REINECKE, *Chairman.*
EBEN PEARSON DORR, *Secretary.*
And others as given on page 33 of Daily Programme.

COMMITTEE ON EXCURSIONS AND ENTERTAINMENT.

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FREDERICK K. MIXER, *Secretary.*
And others as given on page 33 of Daily Programme.

COMMITTEE ON MAILS AND TELEGRAPH.

FRANK C. PERKINS, *Chairman.*
A. C. TERRY, *Secretary.*
And others as given on page 33 of Daily Programme.

COMMITTEE ON RAILROADS.

EDSON J. WEEKS, *Chairman.*
HARRY PARRY, *Secretary.*
And others as given on page 34 of Daily Programme.

LADIES' RECEPTION COMMITTEE.

MRS. ROBERT P. WILSON, *Chairman.*
MRS. LUCIEN HOWE, *Vice-Chairman.*
MRS. LILY LORD TIFFT, *Secretary.*
And others as given on page 34 of Daily Programme.

COMMITTEE ON ROOMS AND PLACES OF MEETING.

HON. H. P. EMERSON, *Chairman.*
FREDERICK A. VOGT, *Secretary.*
And others as given on page 34 of Daily Programme.

COMMITTEE ON HOTELS AND LODGINGS.

DR. LEE H. SMITH, *Chairman.*
DR. CHAUNCEY P. SMITH, *Secretary.*
And others as given on page 35 of Daily Programme.

RECEPTION COMMITTEE.

HON. CHAS. DANIELS, *Chairman.*
WILLIAM H. GRATWICK, *Secretary.*
And others as given on page 35 of Daily Programme.

9)

MEETINGS AND OFFICERS OF THE AMERICAN ASSOCIATION OF GEOLOGISTS AND NATURALISTS.

MEETING.	DATE.	PLACE.	CHAIRMAN.	SECRETARY.	ASSIS'T SEC'Y.	TREASURER.
1st	April 2, 1840,	Philadelphia,	Edward Hitchcock,*	L. C. Beck,*		
2d	April 5, 1841,	Philadelphia,	Benjamin Silliman,*	L. C. Beck.*	B. Silliman, Jr.,* C. B. Trego,*	
3d	April 25, 1842,	Boston,	S. G. Morton,*	C. T. Jackson,*	J. D. Whitney,* M. B. Williams,*	
4th	April 26, 1843,	Albany,	Henry D. Rogers,*	B. Silliman, Jr.,*		John Locke.*
5th	May 8, 1844,	Washington,	John Locke,*	B. Silliman, Jr.,* O. P. Hubbard,		Douglas Houghton.*
6th	April 30, 1845,	New Haven,	Wm. B. Rogers,*	B. Silliman, Jr.,* J. Lawrence Smith,*		Douglas Houghton.*
7th	Sept. 2, 1846,	New York,	C. T. Jackson.*	B. Silliman, Jr.,*		E. C. Herrick.*
8th	Sept. 20. 1847.	Boston,	Wm. B. Rogers,†*	Jeffries Wyman,*		B. Silliman. Jr.*

* Deceased.

† Professor ROGERS, as chairman of this last meeting, called the first meeting of the new Association to order and presided until it was fully organized by the adoption of a constitution. As he was thus the first presiding officer of the new Association, it was directed at the Hartford meeting that his name be placed at the head of the Past Presidents of the American Association for the Advancement of Science.

MEETINGS.	PLACE.	DATE.	MEMBERS IN ATTENDANCE.	NUMBER OF MEMBERS.
1.	Philadelphia	Sept. 20, 1848	?	461
2.	Cambridge	Aug. 14, 1849	?	540
3.	Charleston	Mar. 12, 1850	?	622
4.	New Haven	Aug. 19, 1850	?	704
5.	Cincinnati	May 5, 1851	87	800
6.	Albany	Aug. 19, 1851	194	769
7.	Cleveland	July 28, 1853	?	940
8.	Washington	April 26, 1854	168	1004
9.	Providence	Aug. 15, 1855	166	605
10.	2nd Albany	Aug. 20, 1856	381	722
11.	Montreal	Aug. 12, 1857	351	946
12.	Baltimore	April 28, 1858	190	962
13.	Springfield	Aug. 3, 1859	190	862
14.	Newport	Aug. 1, 1860	135	644
15.	Buffalo	Aug. 15, 1866	79	637
16.	Burlington	Aug. 21, 1867	73	415
17.	Chicago	Aug. 5, 1868	259	686
18.	Salem	Aug. 18, 1869	244	511
19.	Troy	Aug. 17, 1870	188	536
20.	Indianapolis	Aug. 16, 1871	196	668
21.	Dubuque	Aug. 15, 1872	164	610
22.	Portland	Aug. 20, 1873	195	670
23.	Hartford	Aug. 12, 1874	224	722
24.	Detroit	Aug. 11, 1875	165	807
25.	2nd Buffalo	Aug. 23, 1876	215	867
26.	Nashville	Aug. 29, 1877	173	953
27.	St. Louis	Aug. 21, 1878	134	962
28.	Saratoga	Aug. 27, 1879	256	1030
29.	Boston	Aug. 25, 1880	997	1555
30.	2nd Cincinnati	Aug. 17, 1881	500	1699
31.	2nd Montreal	Aug. 23, 1882	937	1922
32.	Minneapolis	Aug. 15, 1883	328	2033
33.	2nd Philadelphia	Sept. 3, 1884	1261*	1981
34.	Ann Arbor	Aug. 26, 1885	364	1956
35.	3d Buffalo	Aug. 18, 1886	445	1886
36.	New York	Aug. 10, 1887	729	1956
37.	2nd Cleveland	Aug. 14, 1888	342	1964
38.	Toronto	Aug. 26, 1889	424	1952
39.	2d Indianapolis	Aug. 19, 1890	364	1944
40.	2d Washington	Aug. 19, 1891	653†	2054
41.	Rochester	Aug. 17, 1892	456	2037
42.	Madison	Aug. 17, 1893	290	1939
43.	Brooklyn	Aug. 15, 1894	488	1802
44.	2d Springfield	Aug. 28, 1895	368	1913
45.	4th Buffalo	Aug. 24, 1896	333	1890

*Including members of the British Association and other foreign guests.
†Including twenty-four Foreign Honorary members for the meeting.

OFFICERS OF THE MEETINGS OF THE ASSOCIATION.

[The number before the name is that of the meeting; the year of the meeting follows the name; the asterisk after a name indicates that the member is deceased.]

PRESIDENTS.

1. { WM. B. ROGERS,* 1848.
   { W. C. REDFIELD,* 1848.
2. JOSEPH HENRY,* 1849.
3, 4, 5. A. D. BACHE,* March meeting, 1850, in absence of JOSEPH HENRY.* August meeting, 1850. May meeting, 1851.
6. LOUIS AGASSIZ,* August meeting, 1851.
(No meeting in 1852).
7. BENJAMIN PIERCE,* 1853.
8. JAMES D. DANA,* 1854.
TORREY,* 1855.
10. JAMES HALL, 1856.
11, 12. ALEXIS CASWELL,* 1857, in place of J. W. BAILEY,* deceased. 1858, in absence of JEFFRIES WYMAN.*
13. STEPHEN ALEXANDER,* 1859.
14. ISAAC LEA,* 1860.
(No meetings for 1861–65).
15. F. A. P. BARNARD,* 1866.
16. J. S. NEWBERRY,* 1867.
17. B. A. GOULD,* 1868.
18. J. W. FOSTER,* 1869.
19. T. STERRY HUNT,* 1870, in the absence of WM. CHAUVENET.*
20. ASA GRAY,* 1871.
21. J. LAWRENCE SMITH,* 1872.
22. JOSEPH LOVERING,* 1873.
23. J. L. LECONTE,* 1874.
24. J. E. HILGARD,* 1875.
25. WILLIAM B. ROGERS,* 1876.
26. SIMON NEWCOMB, 1877.
27. O. C. MARSH, 1878.
28. G. F. BARKER, 1879.
29. LEWIS H. MORGAN,* 1880.
30. G. J. BRUSH, 1881.
31. J. W. DAWSON, 1882.
32. C. A. YOUNG, 1883.
33. J. P. LESLEY, 1884.
34. H. A. NEWTON,* 1885.
35. EDWARD S. MORSE, 1886.
36. S. P. LANGLEY, 1887.
37. J. W. POWELL, 1888
38. T. C. MENDENHALL, 1889.
39. G. LINCOLN GOODALE, 1890.
40. ALBERT B PRESCOTT, 1891.
41. JOSEPH LECONTE, 1892.
42. WILLIAM HARKNESS, 1893.
43. DANIEL G. BRINTON, 1894.
44. E. W. MORLEY, 1895.
45. EDWARD D. COPE, 1896.
46. WOLCOTT GIBBS, 1897.

VICE PRESIDENTS.

There were no Vice Presidents until the 11th meeting when there was a single Vice President for each meeting. At the 24th meeting the Association met in Sections A and B, each presided over by a Vice President. At the 31st meeting nine sections were organized, each with a Vice President as its presiding officer. In 1886, Section G (Microscopy) was given up. In 1892, Section F was divided into F, Zoology; G, Botany.

1857–1874.

11. ALEXIS CASWELL,* 1857, acted as President.
12. JOHN E. HOLBROOK,* 1858, not present.
13. EDWARD HITCHCOCK,* 1859.
14. B. A. GOULD,* 1860.
15. A. A. GOULD,* 1866, in absence of R. W. GIBBES.
16. WOLCOTT GIBBS, 1867.
17. CHARLES WHITTLESEY,* 1868.
18. OGDEN N. ROOD, 1869.
19. T. STERRY HUNT,* 1870, acted as President.
20. G. F. BARKER, 1871.
21. ALEXANDER WINCHELL,* 1872.
22. A. H. WORTHEN,* 1873, not present.
23. C. S. LYMAN,* 1874.

1875–1881.

Section A.—Mathematics, Physics and Chemistry.

24. H. A. NEWTON,* 1875.
25. C. A. YOUNG, 1876.
26. R. H. THURSTON, 1877, in the absence of E. C. PICKERING.
27. R. H. THURSTON, 1878.
28. S. P. LANGLEY, 1879.
29. ASAPH HALL, 1880.
30. WILLIAM HARKNESS, 1881, in the absence of A. M. MAYER

Section B.—Natural History.

24. J. W. DAWSON, 1875.
25. EDWARD S. MORSE, 1876.
26. O. C. MARSH, 1877.
27. AUG. R. GROTE, 1878.
28. J. W. POWELL, 1879.
29. ALEXANDER AGASSIZ, 1880.
30. EDWARD T. COX, 1881, in the absence of GEORGE ENGELMANN.*

CHAIRMEN OF SUBSECTIONS, 1875–1881.

Subsection of Chemistry.

24. S. W. JOHNSON, 1875.
25. G. F. BARKER, 1876.
26. N. T. LUPTON,* 1877.
27. F. W. CLARKE, 1878.
28. F. W. CLARKE, 1879, in the absence of IRA REMSEN.
29. J. M. ORDWAY, 1880.
30. G. C. CALDWELL, 1881, in the absence of W. R. NICHOLS.*

Subsection of Microscopy.

25. R. H. WARD, 1876.
26. R. H. WARD, 1877.
27. R. H. WARD, 1878, in the absence of G. S. BLACKIE.*
28. E. W. MORLEY, 1879.
29. S. A. LATTIMORE, 1880.
30. A. B. HERVEY, 1881.

Subsection of Anthropology.

24. LEWIS H. MORGAN,* 1875.
25. LEWIS H. MORGAN,* 1876.
26. DANIEL WILSON,* 1877, not present.
27. United with Section B.
28. DANIEL WILSON,* 1879.
29. J. W. POWELL, 1880.
30. GARRICK MALLERY,* 1881.

Subsection of Entomology.

30. J. G. MORRIS, 1881.

VICE PRESIDENTS OF SECTIONS, 1882–

Section A.—Mathematics and Astronomy.

31. W. A. ROGERS, 1882, in the absence of WILLIAM HARKNESS.
32. W. A. ROGERS, 1883.
33. H. T. EDDY, 1884.
34. WILLIAM HARKNESS, 1885, in the absence of J. M. VAN VLECK.
35. J. W. GIBBS, 1886.
36. J. R. EASTMAN, 1887, in place of W. FERREL,* resigned.
37. ORMOND STONE, 1888.
38. R. S. WOODWARD, 1889.
39. S. C. CHANDLER, 1890.
40. E. W. HYDE, 1891.
41. J. R. EASTMAN, 1892.
42. C. L. DOOLITTLE, 1893.
43. { G. C. COMSTOCK, 1894. EDGAR FRISBY, 1894. }
44. EDGAR FRISBY, 1895, in place of E. H. HOLDEN, resigned.
45. ALEX. MACFARLANE, 1896 in place of WM. E. STORY, resigned.
46. W. W. BEMAN, 1897.

Section B.—Physics.

31. T. C. MENDENHALL, 1882.
32. H. A. ROWLAND, 1883.
33. J. TROWBRIDGE, 1884.
34. S. P. LANGLEY, 1885, in place of C. F. BRACKETT, resigned.
35. C. F. BRACKETT, 1886.
36. W. A. ANTHONY, 1887.
37. A. A. MICHELSON, 1888.
38. H. S. CARHART, 1889.
39. CLEVELAND ABBE, 1890.
40. F. E. NIPHER, 1891.
41. B. F. THOMAS, 1892.
42. E. L. NICHOLS, 1893.
43. WM. A. ROGERS, 1894.
44. W. LECONTE STEVENS, 1895.
45. CARL LEO MEES, 1896.
46. CARL BARUS, 1897.

Section C.—Chemistry.

31. H. C. BOLTON, 1882.
32. E. W. MORLEY, 1883.
33. J. W. LANGLEY, 1884.
34. N. T. LUPTON,* 1885, in absence of W. R. NICHOLS.*
35. H. W. WILEY, 1886.
36. A. B. PRESCOTT, 1887.
37. C. E. MUNROE, 1888.
38. W. L. DUDLEY, 1889.
39. R. B. WARDER, 1890.
40. R. C. KEDZIE, 1891.
41. ALFRED SPRINGER, 1892.
42. EDWARD HART, 1893.
43. T. H. NORTON, 1894.
44. WM. MCMURTRIE, 1895.
45. W. A. NOYES, 1896.
46. W. P. MASON, 1897.

Section D.—Mechanical Science and Engineering.

31. W. P. TROWBRIDGE,* 1882.
32. DE VOLSON WOOD, 1883, absent, but place was not filled.
33. R. H. THURSTON, 1884.
34. J. BURKITT WEBB, 1885.
35. O. CHANUTE, 1886.
36. E. B. COXE, 1887.
37. C. J. H. WOODBURY, 1888.
38. JAMES E. DENTON, 1889.
39. JAMES E. DENTON, 1890, in place of A. BEARDSLEY, absent.
40. THOMAS GRAY, 1891.
41. J. B. JOHNSON, 1892.
42. S. W. ROBINSON, 1893.
43. MANSFIELD MERRIMAN, 1894.
44. WILLIAM KENT, 1895.
45. FRANK O. MARVIN, 1896.
46. JOHN GALBRAITH, 1897.

VICE PRESIDENTS OF SECTIONS, CONTINUED.

Section E.—Geology and Geography.

31. E. T. COX, 1882.
32. C. H. HITCHCOCK, 1883.
33. N. H. WINCHELL, 1884.
34. EDWARD ORTON, 1885.
35. T. C. CHAMBERLIN, 1886.
36. G. K. GILBERT, 1887.
37. GEORGE H. COOK,* 1888.
38. CHARLES A. WHITE, 1889.
39. JOHN C. BRANNER, 1890.
40. J. J. STEVENSON, 1891.
41. H. S. WILLIAMS, 1892.
42. CHARLES D. WALCOTT, 1893.
43. SAMUEL CALVIN, 1894.
44. JED. HOTCHKISS, 1895.
45. B. K. EMERSON, 1896.
46. I. C. WHITE, 1897.

Section F.—Biology.

31. W. H. DALL, 1882.
32. W. J. BEAL, 1883.
33. E. D. COPE, 1884.
34. T. J. BURRILL, 1885, in the absence of B. G. WILDER.
35. H. P. BOWDITCH, 1886.
36. W. G. FARLOW, 1887.
37. C. V. RILEY,* 1888.
38. GEORGE L. GOODALE, 1889.
39. C. S. MINOT, 1890.
40. J. M. COULTER, 1891.
41. S. H. GAGE, 1892.

Section F.—Zoölogy.

42. HENRY F. OSBORN, 1893.
43. J. A. LINTNER, 1894, in place of S. H. SCUDDER, resigned.
44. L. O. HOWARD, 1895, in place of D. S. JORDAN, resigned.
45. THEO. GILL, 1896.
46. G. BROWN GOODE,* 1897.

Section G.—Microscopy.

31. A. H. TUTTLE, 1882.
32. J. D. COX, 1883.
33. T. G. WORMLEY, 1884.
34. S. H. GAGE, 1885.

(Section united with F in 1886.)

Section G.—Botany.

42. CHARLES E. BESSEY, 1893.
43. { L. M. UNDERWOOD, 1894. / C. E. BESSEY, 1894. }
44. J. C. ARTHUR, 1895.
45. N. L. BRITTON, 1896.
46. G. F. ATKINSON, 1897.

Section H.—Anthropology.

31. ALEXANDER WINCHELL,* 1882.
32. OTIS T. MASON, 1883.
33. EDWARD S. MORSE, 1884.
34. J. OWEN DORSEY,* 1885, in absence of W. H. DALL.
35. HORATIO HALE, 1886.
36. D. G. BRINTON, 1887.
37. CHARLES C. ABBOTT, 1888.
38. GARRICK MALLERY,* 1889.
39. FRANK BAKER, 1890.
40. JOSEPH JASTROW, 1891.
41. W. H. HOLMES, 1892.
42. J. OWEN DORSEY,* 1893.
43. FRANZ BOAS, 1894.
44. F. H. CUSHING, 1895.
45. ALICE C. FLETCHER, 1896.
46. W J MCGEE, 1897.

Section I.—Economic Science and Statistics.

31. E. B. ELLIOTT,* 1882.
32. FRANKLIN B. HOUGH,* 1883.
33. JOHN EATON,* 1884.
34. EDWARD ATKINSON, 1885.
35. JOSEPH CUMMINGS,* 1886.
36. H. E. ALVORD, 1887.
37. CHARLES W. SMILEY, 1888.
38. CHARLES S. HILL, 1889.
39. J. RICHARDS DODGE, 1890.
40. EDMUND J. JAMES, 1891.
41. LESTER F. WARD, 1892, in place of S. DANA HORTON,* resigned.
42. WILLIAM H. BREWER, 1893.
43. HENRY FARQUHAR, 1894.
44. B. E. FERNOW, 1895.
45. W. L. LAZENBY, 1896.
46. R. T. COLBURN, 1897.

SECRETARIES.

General Secretaries, 1848–

1. WALTER R. JOHNSON,* 1848.
2. EBEN N. HORSFORD,* 1849, in the absence of JEFFRIES WYMAN.*
3. L. R. GIBBS, 1850, in absence of E. C. HERRICK.*
4. E. C. HERRICK,* 1850.
5. WILLIAM B. ROGERS,* 1851, in absence of E. C. HERRICK.*
6. WILLIAM B. ROGERS,* 1851.
7. S. ST. JOHN,* 1853, in absence of J. D. DANA.*
8. J. LAWRENCE SMITH,* 1854.
9. WOLCOTT GIBBS, 1855.
10. B. A. GOULD,* 1856.
11. JOHN LECONTE,* 1857.
12. W. M. GILLESPIE,* 1858, in absence of WM. CHAUVENET.*
13. WILLIAM CHAUVENET,* 1859.
14. JOSEPH LECONTE, 1860.
15. ELIAS LOOMIS,* 1866, in the absence of W. P. TROWBRIDGE*
16. C. S LYMAN,* 1867.
17. SIMON NEWCOMB, 1868, in place of A. P. ROCKWELL, called home.
18. O. C. MARSH, 1869.
19. F. W. PUTNAM, 1870, in absence of C. F. HARTT.*
20. F. W. PUTNAM, 1871.
21. EDWARD S. MORSE, 1872.
22. C. A. WHITE, 1873.
23. A. C. HAMLIN, 1874.
24. S. H. SCUDDER, 1875.
25. T. C. MENDENHALL, 1876.
26. AUG. R. GROTE, 1877.
27. H. C. BOLTON, 1878.
28. H. C. BOLTON, 1879, in the absence of GEORGE LITTLE.
29. J. K. REES, 1880.
30. C. V. RILEY,* 1881.
31. WILLIAM SAUNDERS, 1882.
32. J. R. EASTMAN, 1883.
33. ALFRED SPRINGER, 1884.
34. C. S. MINOT, 1885.
35. S. G WILLIAMS, 1886.
36. WILLIAM H. PETTEE, 1887.
37. JULIUS POHLMAN, 1888.
38. C. LEO MEES, 1889.
39. H. C. BOLTON, 1890.
40. H. W. WILEY, 1891.
41. A. W. BUTLER, 1892.
42. T. H. NORTON, 1893.
43. H. L. FAIRCHILD, 1894.
44. JAS. LEWIS HOWE, 1895.
45. CHARLES R. BARNES, 1896.
46. A. HALL, JR., 1897.

Permanent Secretaries, 1851–

5–7. SPENCER F. BAIRD,* 1851–3.
8–17. JOSEPH LOVERING,* 1854–68.
18. F. W. PUTNAM, 1869, in the absence of J. LOVERING.*
19–21. JOSEPH LOVERING,* 1870–72.
22–23. F. W. PUTNAM, 1873–74.
24–28. F. W. PUTNAM, 1875–79.
29–33. F. W. PUTNAM, 1880–84.
34–38. F. W. PUTNAM, 1885–89.
39–43. F. W. PUTNAM, 1890–94.
44–48. F. W. PUTNAM, 1895–99.

Assistant General Secretaries, 1882-1887.

31. J. R. EASTMAN, 1882.
32. ALFRED SPRINGER, 1883.
33. C. S. MINOT, 1884, in the absence of E. S. HOLDEN.
34. S. G. WILLIAMS, 1885, in the absence of C. C. ABBOTT.
35. W. H. PETTEE, 1886.
36. J. C. ARTHUR, 1887.

Secretaries of the Council, 1888–

37. C. LEO MEES, 1888.
38. H. C. BOLTON, 1889.
39. H. W. WILEY, 1890.
40. A. W. BUTLER, 1891.
41. T. H. NORTON, 1892.
42. H. LEROY FAIRCHILD, 1893.
43. JAS. LEWIS HOWE, 1894.
44. CHARLES R. BARNES, 1895.
45. ASAPH HALL, JR., 1896.
46. D. S. KELLICOTT, 1897.

Secretaries of Section A.—Mathematics, Physics and Chemistry, 1875–81.

24. S. P. LANGLEY, 1875. / T. C. MENDENHALL, 1875.
25. A. W. WRIGHT, 1876.
26. H. C. BOLTON, 1877.
27. F. E. NIPHER, 1878.
28. J. K. REES, 1879.
29. H. B. MASON, 1880.
30. E. T. TAPPAN, 1881, in the absence of JOHN TROWBRIDGE.

Secretaries of Section B.— Natural History, 1875–81.

24. EDWARD S. MORSE, 1875.
25. ALBERT H. TUTTLE, 1876.
26. WILLIAM H. DALL, 1877.
27. GEORGE LITTLE, 1878.
28. WILLIAM H. DALL, 1879, in the absence of A. C. WETHERBY.
29. CHARLES V. RILEY,* 1880.
30. WILLIAM SAUNDERS, 1881.

SECRETARIES OF SUBSECTIONS, 1875–81.

Subsection of Chemistry.

24. F. W. CLARKE, 1875.
25. H. C. BOLTON, 1876.
26. P. SCHWEITZER, 1877.
27. A. P. S. STUART, 1878.
28. W. R. NICHOLS,* 1879.
29. C. E. MUNROE, 1880.
30. ALFRED SPRINGER, 1881, in the absence of R. B. WARDER.

Subsection of Entomology.

30. B. P. MANN, 1881.

Subsection of Anthropology.

24. F. W. PUTNAM, 1875.
25. OTIS T. MASON, 1876.
26, 27. United with Section B.
28, 29, 30. J. G. HENDERSON, 1879–81.

Subsection of Microscopy.

25. E. W. MORLEY, 1876.
26. T. O. SOMMERS, JR., 1877.
27. G. J. ENGELMANN, 1878.
28, 29. A. B. HERVEY, 1879–1880.
30. W. H. SEAMAN, 1881, in the absence of S. P. SHARPLES.

SECRETARIES OF THE SECTIONS, 1882–

Section A.—Mathematics and Astronomy.

31. H. T. EDDY, 1882.
32. G. W. HOUGH, 1883, in the absence of W. W. JOHNSON.
33. G. W. HOUGH, 1884.
34. E. W. HYDE, 1885.
35. S. C. CHANDLER, 1886.
36. H. M. PAUL, 1887.
37. C. C. DOOLITTLE, 1888.
38. G. C. COMSTOCK, 1889.
39. W. W. BEMAN, 1890.
40. F. H. BIGELOW, 1891.
41. WINSLOW UPTON, 1892.
42. C. A. WALDO, 1893, in the absence of A. W. PHILLIPS.
43. J. C. KERSHNER, 1894, in place of W. W. BEMAN, resigned.
44. ASAPH HALL, JR., 1895, in place of E. H. MOORE, resigned.
45. EDWIN B. FROST, 1896.
46. J. MCMAHON, 1897.

Section B.—Physics.

31. C. S. HASTINGS, 1882.
32. F. E. NIPHER, 1883, in the absence of C. K. WEAD.
33. N. D. C. HODGES, 1884.
34. B. F. THOMAS, 1885, in place of A. A. MICHELSON, resigned.
35. H. S. CARHART, 1886.
36. C. LEO MEES, 1887.
37. ALEX. MACFARLANE, 1888.
38. E. L. NICHOLS, 1889.
39. E. M. AVERY, 1890.
40. ALEX. MACFARLANE, 1891.
41. BROWN AYRES, 1892.
42. W. LECONTE STEVENS, 1893.
43. B. W. SNOW, 1894.
44. E. MERRITT, 1895.
45. FRANK P. WHITMAN, 1896.
46. F. BEDELL, 1897.

SECRETARIES OF THE SECTIONS, CONTINUED.

Section C.—Chemistry.

31. ALFRED SPRINGER, 1882.
32. { J. W. LANGLEY, 1883. W. MCMURTRIE, 1883.
33. H. CARMICHAEL, 1884, in the absence of R. B. WARDER.
34. F. P. DUNNINGTON, 1885.
35. W. MCMURTRIE, 1886.
36. C. S. MABERY, 1887.
37. W. L. DUDLEY, 1888.
38. EDWARD HART, 1889.
39. W. A. NOYES, 1890.
40. T. H. NORTON, 1891.
41. JAS. LEWIS HOWE, 1892.
42. H. N. STOKES, 1893, in the absence of J. U. NEF.
43. MORRIS LOEB, 1894, in place of S. M. BABCOCK, resigned
44. { W. P. MASON, 1895. W. O. ATWATER, 1895.
45. FRANK P. VENABLE, 1896.
46. P. C. FREER, 1897.

Section D.—Mechanical Science and Engineering.

31. J. BURKITT WEBB, 1882, in the absence of C. R. DUDLEY.
32. J. BURKITT WEBB, 1883, *pro tempore*.
33. J. BURKITT WEBB, 1884.
34. C. J. H. WOODBURY, 1885.
35. WILLIAM KENT, 1886.
36. G. M. BOND, 1887.
37. ARTHUR BEARDSLEY, 1888.
38. W. B. WARNER, 1889.
39. THOMAS GRAY, 1890.
40. WILLIAM KENT, 1891.
41. O. H. LANDRETH, 1892.
42. D. S. JACOBUS, 1893.
43. JOHN H. KINEALY, 1894.
44. H. S. JACOBY, 1895.
45. JOHN GALBRAITH, 1896.
46. J. H. FLATHER, 1897.

Section E.—Geology and Geography.

31. H. S. WILLIAMS, 1882, in the absence of C. E. DUTTON.
32. A. A. JULIEN, 1883.
33. E. A. SMITH, 1884.
34. G. K. GILBERT, 1885, in the absence of H. C. LEWIS.*
35. E. W. CLAYPOLE, 1886.
36. W. M. DAVIS, 1887, in the absence of T. B. COMSTOCK.
37. JOHN C. BRANNER, 1888.
38. JOHN C. BRANNER, 1889.
39. SAMUEL CALVIN, 1890.
40. W J MCGEE, 1891.
41. R. D. SALISBURY, 1892.
42. W. H. HOBBS, 1893, in place of R. T. HILL, resigned.
43. JED. HOTCHKISS, 1894, in place of W. M. DAVIS, resigned.
44. J. PERRIN SMITH, 1895.
45. W. N. RICE, 1896, in place of A. C. GILL, resigned.
46. C. H. SMYTH, 1897.

Section F.—Biology, 1882–92.

31. WILLIAM OSLER, 1882, in the absence of C. S. MINOT.
32. S. A. FORBES, 1883.
33. C. E. BESSEY, 1884.
34. J. A. LINTNER, 1885, in place of C. H. FERNALD, resigned.
35. J. C. ARTHUR, 1886.
36. J. H. COMSTOCK, 1887.
37. B. H. FERNOW, 1888.
38. A. W. BUTLER, 1889.
39. J. M. COULTER, 1890.
40. A. J. COOK, 1891.
41. B. D. HALSTED, 1892.

Section F.—Zoölogy.

42. L. O. HOWARD, 1893.
43. JOHN B. SMITH, 1894, in place of WM. LIBBY, JR., resigned.
44. C. W. HARGITT, 1895, in place of S. A. FORBES, resigned.
45. D. S. KELLICOTT, 1896.
46. C. C. NUTTING, 1897.

SECRETARIES OF THE SECTIONS, CONTINUED.

Section G.—Microscopy, 1882–85.

31. ROBERT BROWN, JR., 1882.
32. CARL SEILER, 1883.
33. ROMYN HITCHCOCK, 1884.
34. W. H. WALMSLEY, 1885.

Section G.—Botany.

42. B. T. GALLOWAY, 1893, in the absence of F. V. COVILLE.
43. CHARLES R. BARNES, 1894.
44. { B. T. GALLOWAY, 1895. M. B. WAITE, 1895.
45. GEORGE F. ATKINSON, 1896.
46. F. C. NEWCOMBE, 1897.

Section H.—Anthropology.

31. OTIS T. MASON, 1882.
32. G. H. PERKINS, 1883.
33. G. H. PERKINS, 1884, in the absence of W. H. HOLMES.
34. ERMINNIE A. SMITH,* 1885.
35. A. W. BUTLER, 1886.
36. CHARLES C. ABBOTT, 1887, in absence of F. W. LANGDON.
37. FRANK BAKER, 1888.
38. W. M. BEAUCHAMP, 1889.
39. JOSEPH JASTROW, 1890.
40. W. H. HOLMES, 1891.
41. W. M. BEAUCHAMP, 1892, in place of S. CULIN, resigned.
42. WARREN K. MOOREHEAD, 1893.
43. A. F. CHAMBERLIN, 1894.
44. { STEWART CULIN and W. W. TOOKER, 1895, in place of ANITA N. MCGEE resigned.
45. G. H. PERKINS, 1896, in place of J. G. BOURKE,* deceased.
46. H. I. SMITH, 1897.

Section I.—Economic Science and Statistics.

31. { FRANKLIN B. HOUGH,* 1882. J. RICHARDS DODGE, 1882.
32. JOSEPH CUMMINGS,* 1883.
33. CHARLES W. SMILEY, 1884.
34. CHARLES W. SMILEY, 1885, in absence of J. W. CHICKERING.
35. H. E. ALVORD, 1886.
36. W. R. LAZENBY, 1887.
37. CHARLES S. HILL, 1888.
38. J. RICHARDS DODGE, 1889.
39. B. E. FERNOW, 1890.
40. B. E. FERNOW, 1891.
41. HENRY FARQUHAR, 1892, in place of L. F. WARD made Vice-president.
42. NELLIE S. KEDZIE, 1893.
43. MANLEY MILES, 1894.
44. W. R. LAZENBY, 1895, in place of E. A. ROSS, resigned.
45. R. T. COLBURN, 1896.
46. ARCHIBALD BLUE, 1897.

TREASURERS.

1. JEFFRIES WYMAN,* 1848.
2. A. L. ELWYN,* 1849.
3. ST. J. RAVENEL,* 1850, in the absence of A. L. ELWYN.*
4. A. L. ELWYN,* 1850.
5. SPENCER F. BAIRD,* 1851, in absence of A. L. ELWYN.*

6–7. A. L. ELWYN,* 1851–1853.

8. J. L. LECONTE,* 1854, in absence of A. L. ELWYN.*

9–19. A. L. ELWYN,* 1855–1870.

20–30. WILLIAM S. VAUX,* 1871–1881.

32–42. WILLIAM LILLY,* 1882–1893.

43–46. R. S. WOODWARD, 1894–97.

COMMONWEALTH OF MASSACHUSETTS.

IN THE YEAR ONE THOUSAND EIGHT HUNDRED AND SEVENTY-FOUR.

AN ACT

To Incorporate the "American Association for the Advancement of Science."

Be it enacted by the Senate and House of Representatives, in General Court assembled, and by the authority of the same, as follows:

Section 1. Joseph Henry of Washington, Benjamin Pierce of Cambridge, James D. Dana of New Haven, James Hall of Albany, Alexis Caswell of Providence, Stephen Alexander of Princeton, Isaac Lea of Philadelphia, F. A. P. Barnard of New York, John S. Newberry of Cleveland, B. A. Gould of Cambridge, T. Sterry Hunt of Boston, Asa Gray of Cambridge, J. Lawrence Smith of Louisville, Joseph Lovering of Cambridge and John LeConte of Philadelphia, their associates, the officers and members of the Association, known as the "American Association for the Advancement of Science," and their successors, are hereby made a corporation by the name of the "American Association for the Advancement of Science," for the purpose of receiving, purchasing, holding and conveying real and personal property, which it now is, or hereafter may be, possessed of, with all the powers and privileges, and subject to the restrictions, duties and liabilities set forth in the general laws which now or hereafter may be in force and applicable to such corporations.

Section 2. Said corporation may have and hold by purchase, grant, gift or otherwise, real estate not exceeding one hundred thousand dollars in value, and personal estate of the value of two hundred and fifty thousand dollars.

Section 3. Any two of the corporators above named are hereby authorized to call the first meeting of the said corporation in the month of August next ensuing, by notice thereof "by mail," to each member of the said Association.

Section 4. This act shall take effect upon its passage.

House of Representatives, March 10, 1874.
Passed to be enacted,
John F. Sanford, *Speaker*.

In Senate, March 17, 1874.
Passed to be enacted.
Geo. B. Loring, *President*.

March 19, 1874.
Approved,
W. B. Washburn.

Secretary's Department,
Boston, April 3, 1874.
A true copy, Attest:
David Pulsifer,
Deputy Secretary of the Commonwealth.

CONSTITUTION

OF THE

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

Incorporated by Act of the General Court of the Commonwealth of Massachusetts

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OBJECTS.

ARTICLE 1. The objects of the Association are, by periodical and migratory meetings, to promote intercourse between those who are cultivating science in different parts of America, to give a stronger and more general impulse and more systematic direction to scientific research, and to procure for the labors of scientific men increased facilities and a wider usefulness.

MEMBERS, FELLOWS, PATRONS AND HONORARY FELLOWS.

ART. 2. The Association shall consist of Members, Fellows, Patrons, Corresponding Members and Honorary Fellows.

ART. 3. Any person may become a Member of the Association upon recommendation in writing by two members or fellows, and election by the Council. Any incorporated scientific society or institution, or any public or incorporated library, may be enrolled as a member of the Association by vote of the Council by payment of the initiation fee; such society, institution or library may be represented by either the President, Curator, Director or Librarian presenting proper credentials at any meeting of the Association for which the assessment has been paid.

ART. 4. Fellows shall be elected by the Council from such of the members as are professionally engaged in science, or have by their labors aided in advancing science. The election of fellows shall be by ballot and a majority vote of the members of the Council at a designated meeting of the Council.

ART. 5. Any person paying to the Association the sum of one thousand dollars shall be classed as a Patron, and shall be entitled to all the privileges of a member and to all its publications.

ART. 6. Honorary Fellows of the Association, not exceeding three for each section, may be elected; the nominations to be made by the Council and approved by ballot in the respective sections before election by ballot in General Session. Honorary Fellows shall be entitled to all the privileges of Fellows and shall be exempt from all fees and assessments, and entitled to all publications of the Association issued after the date of their election. Corresponding Members shall consist of such scientists not residing in America as may be elected by the Council, and their number shall be limited to fifty. Corresponding Members shall be entitled to all the privileges of members and to the annual volumes of Proceedings published subsequent to their election.

ART. 7. The name of any member or fellow two years in arrears for annual dues shall be erased from the list of the Association, provided that two notices of indebtedness, at an interval of at least three months, shall have been given; and no such person shall be restored until he has paid his arrearages or has been reëlected. The Council shall have power to exclude from the Association any member or fellow, on satisfactory evidence that said member or fellow is an improper person to be connected with the Association, or has in the estimation of the Council made improper use of his membership or fellowship.

ART. 8. No member or fellow shall take part in the organization of, or hold office in, more than one section at any one meeting.

OFFICERS.

ART. 9. The officers of the Association shall be elected by ballot in General Session from the fellows, and shall consist of a President, a Vice President from each section, a Permanent Secretary, a General Secretary, a Secretary of the Council, a Treasurer, and a Secretary of each Section; these, with the exception of the Permanent Secretary, shall be elected at each meeting for the following one and, with the exception of the Treasurer and the Permanent Secretary, shall not be reëligible for the next two meetings. The term of office of Permanent Secretary shall be five years.

ART. 10. The President, or, in his absence, the senior Vice President present, shall preside at all General Sessions of the Association and at all meetings of the Council. It shall also be the duty of the President to give an address at a General Session of the Association at the meeting following that over which he presided.

ART. 11. The Vice Presidents shall be chairmen of their respective

Sections, and of their Sectional Committees, and it shall be part of their duty to give an address, each before his own section, at such time as the council shall determine. The Vice Presidents may appoint temporary Chairmen to preside over the sessions of their sections, but shall not delegate their other duties. The Vice Presidents shall have seniority in order of their continuous membership in the Association.

ART. 12. The General Secretary shall be the Secretary of all General Sessions of the Association, and shall keep a record of the business of these sessions. He shall receive the records from the Secretaries of the Sections, which, after examination, he shall transmit with his own records to the Permanent Secretary within two weeks after the adjournment of the meeting.

ART. 13. The Secretary of the Council shall keep the records of the Council. He shall give to the Secretary of each Section the titles of papers assigned to it by the Council. He shall receive proposals for membership and bring them before the Council.

ART. 14. The Permanent Secretary shall be the executive officer of the Association under the direction of the Council. He shall attend to all business not specially referred to committees nor otherwise constitutionally provided for. He shall keep an account of all business that he has transacted for the Association, and make annually a general report for publication in the annual volume of Proceedings. He shall attend to the printing and distribution of the annual volume of Proceedings, and all other printing ordered by the Association. He shall issue a circular of information to members and fellows at least three months before each meeting, and shall, in connection with the Local Committee, make all necessary arrangements for the meetings of the Association. He shall provide the Secretaries of the Association with such books and stationery as may be required for their records and business, and shall provide members and fellows with such blank forms as may be required for facilitating the business of the Association. He shall collect all assessments and admission fees, and notify members and fellows of their election, and of any arrearages. He shall receive, and bring before the Council, the titles and abstracts of papers proposed to be read before the Association. He shall keep an account of all receipts and expenditures of the Association, and report the same annually at the first meeting of the Council, and shall pay over to the Treasurer such unexpended funds as the Council may direct. He shall receive and hold in trust for the

Association all books, pamphlets and manuscripts belonging to the Association, and allow the use of the same under the provisions of the Constitution and the orders of the Council. He shall receive all communications addressed to the Association during the intervals between meetings, and properly attend to the same. He shall at each meeting report the names of fellows and members who have died since the preceding meeting. He shall be allowed a salary which shall be determined by the Council, and may employ one or more clerks at such compensation as may be agreed upon by the Council.

ART. 15. The Treasurer shall invest the funds received by him in such securities as may be directed by the Council. He shall annually present to the Council an account of the funds in his charge. No expenditure of the principal in the hands of the Treasurer shall be made without a unanimous vote of the Council, and no expenditure of the income received by the Treasurer shall be made without a two-thirds vote of the Council. The Treasurer shall give bonds for the faithful performance of his duty in such manner and sum as the Council shall from time to time direct.

ART. 16. The Secretaries of the Sections shall keep the records of their respective sections, and, at the close of the meeting, give the same, including the records of subsections, to the General Secretary. They shall also be the Secretaries of the Sectional Committees. The Secretaries shall have seniority in order of their continuous membership in the Association.

ART. 17. In case of a vacancy in the office of the President, one of the Vice Presidents shall be elected by the Council as the President of the meeting. Vacancies in the offices of Vice President, Permanent Secretary, General Secretary, Secretary of the Council, and Treasurer, shall be filled by nomination of the Council and election by ballot in General Session. A vacancy in the office of Secretary of a Section shall be filled by nomination and election by ballot in the Section.

ART. 18. The Council shall consist of the past Presidents, and the Vice Presidents of the last meeting, together with the President, the Vice Presidents, the Permanent Secretary, the General Secretary, the Secretary of the Council, the Secretaries of the Sections, and the Treasurer of the current meeting, with the addition of one fellow elected from each Section by ballot on the first day of its meeting. The members present at any regularly called meeting of the Council, provided there are at least five,

shall form a quorum for the transaction of business. The Council shall meet on the day preceding each annual meeting of the Association, and arrange the programme for the first day of the sessions. The time and place of this first meeting shall be designated by the Permanent Secretary. Unless otherwise agreed upon, regular meetings of the Council shall be held in the Council room at 9 o'clock, A.M., on each day of the meeting of the Association. Special meetings of the Council may be called at any time by the President. The Council shall be the board of supervision of the Association, and no business shall be transacted by the Association that has not first been referred to, or originated with, the Council. The Council shall receive and assign papers to the respective sections; examine and, if necessary, exclude papers; decide which papers, discussions and other proceedings shall be published, and have the general direction of the publications of the Association; manage the financial affairs of the Association; arrange the business and programmes for General Sessions; suggest subjects for discussion, investigation or reports; elect members and fellows; and receive and act upon all invitations extended to the Association and report the same at a General Session of the Association. The Council shall receive all reports of Special Committees and decide upon them, and only such shall be read in General Session as the Council shall direct. The Council shall appoint at each meeting the following sub-committees who shall act, subject to appeal to the whole Council, until their successors are appointed at the following meeting: 1, on Papers and Reports; 2, on Members; 3, on Fellows.

ART. 19. The Nominating Committee shall consist of the Council, and one member or fellow elected by each of the Sections. It shall be the duty of this Committee to meet at the call of the President and nominate the general officers for the following meeting of the Association. It shall also be the duty of this Committee to recommend the time and place for the next meeting. The Vice President and Secretary of each Section shall be recommended to the Nominating Committee by a sub-committee consisting of the Vice President, Secretary, and three members or fellows elected by the Section.

MEETINGS.

ART. 20. The Association shall hold a public meeting annually, for one week or longer, at such time and place as may be determined by vote of the Association, and the preliminary arrangements for each meeting shall be made by the Local Committee, in conjunction with the Permanent Secretary and such other persons as the Council may designate.

ART. 21. A General Session shall be held at 10 o'clock, A. M., on the first day of the meeting, and at such other times as the Council may direct.

SECTIONS AND SUBSECTIONS.

ART. 22. The Association shall be divided into Sections, namely:—A, *Mathematics and Astronomy*; B, *Physics*; C, *Chemistry, including its application to agriculture and the arts*; D, *Mechanical Science and Engineering*; E, *Geology and Geography*; F, *Zoölogy*; G, *Botany*; H, *Anthropology*; I, *Social and Economic Science*. The Council shall have power to consolidate any two or more Sections temporarily, and such consolidated Sections shall be presided over by the senior Vice President and Secretary of the Sections comprising it.

ART. 23. Immediately on the organization of a Section there shall be three fellows elected by ballot after open nomination, who, with the Vice President and Secretary and the Vice President and Secretary of the preceding meeting shall form its Sectional Committee. The Sectional Committees shall have power to fill vacancies in their own numbers. Meetings of the Sections shall not be held at the same time with a General Session.

ART. 24. The Sectional Committee of any Section may at its pleasure form one or more temporary Subsections, and may designate the officers thereof. The Secretary of a Subsection shall, at the close of the meeting, transmit his records to the Secretary of the Section.

ART. 25. A paper shall not be read in any Section or Subsection until it has been received from the Council and placed on the programme of the day by the Sectional Committee.

SECTIONAL COMMITTEES.

ART. 26. The Sectional Committees shall arrange and direct the business of their respective Sections. They shall prepare the daily programmes and give them to the Permanent Secretary for printing at the earliest moment practicable. No titles of papers shall be entered on the daily programmes except such as have passed the Council. No change shall be made in the programme for the day in a Section without the consent of the Sectional Committee. The Sectional Committees may refuse to place the title of any paper on the programme; but every such title, with the abstract of the paper or the paper itself, must be returned to the Council with the reasons why it was refused.

ART. 27. The Sectional Committees shall examine all papers and abstracts referred to the Sections, and they shall not place on the programme

any paper inconsistent with the character of the Association; and to this end they have power to call for any paper, the character of which may not be sufficiently understood from the abstract submitted.

Papers and Communications.

Art. 28. All members and fellows must forward to the Permanent Secretary, as early as possible, and when practicable before the convening of the Association, full titles of all the papers which they propose to present during the meeting, with a statement of the time that each will occupy in delivery, and also such abstracts of their contents as will give a general idea of their nature; and no title shall be referred by the Council to the Sectional Committee until an abstract of the paper or the paper itself has been received.

Art. 29. If the author of any paper be not ready at the time assigned, the title may be dropped to the bottom of the list.

Art. 30. Whenever practicable, the proceedings and discussions at General Sessions, Sections and Subsections shall be reported by professional reporters, but such reports shall not appear in print as the official reports of the Association unless revised by the Secretaries.

Printed Proceedings.

Art. 31. The Permanent Secretary shall have the Proceedings of each meeting printed in an octavo volume as soon after the meeting as possible, beginning one month after adjournment. Authors must prepare their papers or abstracts ready for the press, and these must be in the hands of the Secretaries of the Sections before the final adjournment of the meeting, otherwise only the titles will appear in the printed volume. The Council shall have power to order the printing of any paper by abstract or title only. Whenever practicable, proofs shall be forwarded to authors for revision. If any additions or substantial alterations are made by the author of a paper after its submission to the Secretary, the same shall be distinctly indicated. Illustrations must be provided for by the authors of the papers, or by a special appropriation from the Council. Immediately on publication of the volume, a copy shall be forwarded to every member and fellow of the Association who shall have paid the assessment for the meeting to which it relates, and it shall also be offered for sale by the Permanent Secretary at such price as may be determined by the Council. The Council shall also designate the institutions to which copies shall be distributed.

Local Committee.

Art. 32. The Local Committee shall consist of persons interested in the objects of the Association and residing at or near the place of the proposed meeting. It is expected that the Local Committee, assisted by the officers of the Association, will make all essential arrangements for the meeting, and issue a circular giving necessary particulars, at least one month before the meeting.

Library of the Association.

Art. 33. All books and pamphlets received by the Association shall be in the charge of the Permanent Secretary, who shall have a list of the same printed and shall furnish a copy to any member or fellow on application. Members and fellows who have paid their assessments in full shall be allowed to call for books and pamphlets, which shall be delivered to them at their expense, on their giving a receipt agreeing to make good any loss or damage and to return the same free of expense to the Secretary at the time specified in the receipt given. All books and pamphlets in circulation must be returned at each meeting. Not more than five books, including volumes, parts of volumes, and pamphlets, shall be held at one time by any member or fellow. Any book may be withheld from circulation by order of the Council. [The Library of the Association was, by vote of the Council in 1895, placed on deposit in the Library of the University of Cincinnati, Ohio. Members can obtain the use of books by writing to the Librarian of the University Library, Cincinnati, Ohio.]

Admission Fee and Assessments.

Art. 34. The admission fee for members shall be five dollars in addition to the annual assessment. On the election of any member as a fellow an additional fee of two dollars shall be paid.

Art. 35. The annual assessment for members and fellows shall be three dollars.

Art. 36. Any member or fellow who shall pay the sum of fifty dollars to the Association, at any one time, shall become a Life Member, and as such, shall be exempt from all further assessments, and shall be entitled to the Proceedings of the Association. All money thus received shall be invested as a permanent fund, the income of which, during the life of the member, shall form a part of the general fund of the Association; but, after his death, shall be used only to assist in original research, unless otherwise directed by unanimous vote of the Council.

ART. 37. All admission fees and assessments must be paid to the Permanent Secretary, who shall give proper receipts for the same.

ACCOUNTS.

ART. 38. The accounts of the Permanent Secretary and of the Treasurer shall be audited annually, by Auditors appointed by the Council.

ALTERATIONS OF THE CONSTITUTION.

ART. 39. No part of this Constitution shall be amended or annulled, without the concurrence of three-fourths of the members and fellows present in General Session, after notice given at a General Session of a preceding meeting of the Association.

MEMBERS

OF THE

AMERICAN ASSOCIATION

FOR THE

ADVANCEMENT OF SCIENCE.[1]

PATRONS.[2]

THOMPSON, MRS. ELIZABETH, Stamford, Conn. (22).
LILLY, GEN. WILLIAM, Mauch Chunk, Pa. (28). (Died Dec. 1, 1893.)
HERRMAN, MRS. ESTHER, 59 West 56th St., New York, N. Y. (29).

CORRESPONDING MEMBERS.[3]

Warington, Robert, F.R.S., Rothamsted, Harpenden, England (40). **C**

MEMBERS.[4]

Abbe, Cleveland, jr., 2017 I St., Washington, D. C. (44). **E**
Abraham, Abraham, Brooklyn, N. Y. (43).
Adams, C. E., M.D., Ballentine Gym. New Brunswick, N. J. (43). **F**
Aitkin, Miss Clara I., 210 Madison St., Brooklyn, N. Y. (40). **H**
Aitkin, Miss Helen J., 210 Madison St., Brooklyn, N. Y. (40). **E H**
Alden, Jno., Pacific Mills, Lawrence, Mass. (36).

[1] The numbers in parentheses indicate the meeting at which the member was elected. The black letters at the end of line indicate the sections to which members elect to belong. The Constitution requires that the names of all members two or more years in arrears shall be omitted from the list, but their names will be restored on payment of arrearages. Members not in arrears are entitled to the annual volume of Proceedings bound in paper. *The payment of ten dollars at one time entitles a member to the subsequent volumes to which he may be entitled, bound in cloth, or by the payment of twenty dollars, to such volumes bound in half morocco.*

[2] Persons contributing one thousand dollars or more to the Association are classed as Patrons, and are entitled to the privileges of members and to the publications.
The names of Patrons are to remain permanently on the list.

[3] See ARTICLE VI of the Constitution.

[4] Any Member or Fellow may become a Life Member by the payment of fifty dollars. The income of the money derived from a Life Membership is used for the general purposes of the Association during the life of the member; afterwards it is to be used to aid in original research. Life Members are exempt from the annual assessment, and are entitled to the annual volume. The names of Life Members are printed in small capitals in the regular list of Members and Fellows.

Aldis, Owen F., 230 Monadnock Block, Chicago, Ill. (41). **H**
Aldrich, Prof. William Sleeper, West Virginia Univ., Morgantown, W. Va. (43).
Allderdice, Wm. H., P. A. Engineer, U. S. Navy, care Navy Department, Washington, D. C. (33). **D**
Allen, Miss Augusta A., 42 Coulter St., Germantown, Pa. (44). **G**
Allen, J. M., Hartford, Conn. (22). **D**
Allen, Prof. Thomas G., Armour Inst., Chicago, Ill. (43). **C**
Allen, Walter S., 34 So. Sixth St., New Bedford, Mass. (39). **C I**
Anderson, Alexander P., University of Minnesota, Minneapolis, Minn. (45). **G**
Andrews, E. R., Rochester, N. Y. (41).
Appleby, Prof. William R., Univ. of Minnesota, Minneapolis, Minn. (43). **D E**
Appleton, Rev. Edw. W., D.D., Ashbourne, Montgomery Co., Pa. (28).
Appleton, Prof. William H., Ph.D., Swarthmore College, Swarthmore, Pa. (43). **H E**
Archambault, U. E., P. O. Box 1944, Montreal, P. Q., Can. (31).
Archbold, Dr. George, 65 Prospect Place, E. 42nd St., New York, N. Y. (40).
Arms, Miss Jennie M., 18 W. Cedar St., Boston, Mass. (44). **F**
Atkinson, Jno. B., Earlington, Hopkins Co., Ky. (26). **D**
Atwood, Dr. Charles, Moravia, N. Y. (45). **G**
AVERY, SAMUEL P., 4 E. 38th St., New York, N. Y. (36).
Ayer, Edward Everett, Room 12, The Rookery, Chicago, Ill. (37). **H**
Ayres, Horace B., Allamuchy, N. J. (40).

Backus, Truman J., LL.D., Pres. Packer Inst., Brooklyn, N. Y. (43).
Bacon, Chas. A., Beloit, Wis. (36). **A**
Baker, A. G., Springfield, Mass. (44).
Baker, O. M., 499 Main St., Springfield, Mass. (44).
Balch, Samuel W., Yonkers, N. Y. (43).
Balderston, C. Canby, Westtown, Chester Co., Pa. (33). **B**
Baldwin, Herbert B., 215 Market St., Newark, N. J. (43).
Baldwin, Miss Mary A., 28 Fulton St., Newark, N. J. (31). **E H I**
Bancroft, Alonzo C., Elma, Erie Co., N. Y. (41).
Banes, Charles H., 1107 Market St., Philadelphia, Pa. (31). **D**
BANGS, LEMUEL BOLTON, M.D., 127 E. 34th St., New York, N. Y. (36).
Bannan, John F., North Andover, Mass. (44). **C**
Barber, D. H., P. O. Box 83, Springville, Linn Co., Iowa (37).
Barbour, Prof. Ervin H., Univ. of Nebraska, Lincoln, Neb. (45). **E**
Barclay, Robert, A.M., M.D., 3211 Lucas Ave., St. Louis, Mo. (30).
BARGE, B. F., Mauch Chunk, Pa. (33).
Barker, Mrs. Martha M., 26 Eleventh St., Lowell, Mass. (31). **E H**
Barker, Mrs. Mary E., Collinsville, Conn. (45).
Barnard, Charles, 866 Carnegie Hall Studios, West 56th St., New York, N. Y. (43).

Barnett, Miss Katie Porter, Madison, Georgia (44). **A H**
Barnhart, Arthur M., 185 Monroe St., Chicago, Ill. (42).
Barrows, David Prescott, Claremont, Los Angeles Co., Cal. (43). **H**
Barrows, Walter B., Agricultural College, Ingham Co., Mich. (40). **F**
Barton, Prof. Samuel M., Kernstown, Va. (43). **A**
Bascom, Miss Florence, Bryn Mawr Coll., Bryn Mawr, Pa. (42). **E**
Bastin, Edson Sewell, The Philadelphia Coll. of Pharmacy, Philadelphia, Pa. (39).
Bausch, Henry, P. O. Drawer 1033, Rochester, N. Y. (41).
Baxter, James N., care H. E. and C. Baxter, cor. Division and Bedford Sts., Brooklyn, N. Y. (36).
Bay, J. Christian, Bacteriologist of the Iowa State Board of Health, Ames, Iowa (42). **G**
Baylies, Bradford L.B., M.D., 418 Putnam Ave., Brooklyn, N. Y. (43).
Beach, Spencer Ambrose, N. Y. Experiment Station, Geneva, N. Y. (41). **G**
Bean, Thos. E., Box 441, Galena, Ill. (28). **F**
Becher, Franklin A., 406 Irving Place, Milwaukee, Wis. (41). **I A**
Beckwith, Miss Florence, 394 Alexander St., Rochester, N. Y. (45). **G**
Bell, Miss Clara, Springfield, Mass. (43).
BELL, C. M., M.D., 320 Fifth Ave., New York, N. Y. (36).
Benner, Henry (40). **A**
Bennett, Henry C., 256 W. 42nd St., New York, N. Y. (43).
Berry, Daniel, M.D., Carmi, White Co., Ill. (41). **B C E**
Beveridge, David, Iowa Alliance, Des Moines, Iowa (33). **I**
Biddle, James G., 944 Drexel Building, Philadelphia, Pa. (39).
Bien, Julius, 140 Sixth Ave., New York, N. Y. (34). **E H**
Bigelow, Willard Dell, Chem. Div., Dept. of Agric., Washington, D. C. (44). **C**
Biggar, Hamilton F., M.D., 176 Euclid Ave., Cleveland, Ohio (40). **B F**
Billings, Edgar F., 165 High St., Boston, Mass. (44). **C**
Birge, Prof. Edw. A., Univ. of Wis., Madison, Wis. (42). **F**
Biscoe, Prof. Thomas Dwight, 404 Front St., Marietta, Ohio (41). **G**
BISHOP, HEBER R., Mills Building, New York, N. Y. (36).
Blackmar, Abel E., 1074 Bergen St., Brooklyn, N. Y. (43).
Blair, Mrs. Helen Quinche, 409 Broadway, Cincinnati, Ohio (40). **C**
Blake, Edwin Mortimer, 230 Washington Ave., Brooklyn, N. Y. (43).
Blatchford, Eliphalet W., 375 No. La Salle St., Chicago, Ill. (17). **F**
Bleile, Albert M., M.D., 342 S. Fourth St., Columbus, Ohio (37). **F**
BLISH, W. G., Niles, Mich. (33). **B D**
Bodine, Donaldson, Prof. of Zoölogy and Geology, Wabash Coll., Crawfordsville, Ind. (45). **E F**
Bogue, Rev. Horace P. V., Avon, N. Y. (41). **H I**
Booraem, J. V. V., 204 Lincoln Place, Brooklyn, N. Y. (36).
Borner, William, The Majestic, 52 and 54 Walton Place, Chicago, Ill. (44).
Bourland, Addison M., M.D., Van Buren, Ark. (29). **C E F**
Bouton, Chas. L., M.S., 2909 Park Ave., St. Louis, Mo. (40). **A D**

Bowditch, Charles P., 28 State St., Boston, Mass. (43). **H**
Bowers, Miss Virginia K., 61 3d St., Newport, Ky. (27). **F H B C**
Bowker, R. R., 28 Elm St., New York, N. Y. (43). **B**
Boynton, May O., Ph.B., 69 North Prospect St., Burlington, Vt. (44). **C**
BRACKENRIDGE, GEO. W., San Antonio, Texas (41). **I**
Brackett, S. H., St. Johnsbury, Vt. (43).
BRADLEY, ARTHUR C., Newport, N. H. (43).
Bradley, Charles S., P. O. Box 259, Avon, N. Y. (40).
BRADLEY, M. J., 36 Hart St., Brooklyn, N. Y. (43).
Bradley, Milton, Springfield, Mass. (44). **B**
Bramwell, Geo. W., 335 Broadway, New York, N. Y. (43). **D**
Brayton, Miss Sarah H., M.D., Evanston, Ill. (38).
Breckenridge, Prof. Lester P., Champaign, Ill. (41).
Brewster, Mrs. Mary S., Mountainville, Orange Co., N. Y. (43).
Brice, Judge Albert G., 19 Camp St., New Orleans, La. (32). **H**
Briggs, Thomas B., 115 E. 73d St., New York, N. Y. (43).
Brigham, Prof. Albert P., Hamilton, Madison Co., N. Y. (41).
Britton, Wiley, Kansas City, Kansas (40). **F**
Bromwell, Wm., Port Deposit, Md. (40).
Brooks, Prof. Wm. P., Amherst, Mass. (38). **C F**
Brown, Henry A., Westport Point, Mass. (38). **I**
Brown, Jonathan, 390 Broadway, Somerville, Mass. (29).
Brown, Samuel B., Morgantown, W. Va. (40). **E**
Brundage, Albert H., Ph.G., M.D., 1153 Gates Ave., Brooklyn, N. Y. (43). **F G H**
Brush, Geo. W., M.D., 2 Spencer Place, Brooklyn, N. Y. (43). **B H**
Bryant, Miss D. L., 998 Spring Garden St., Greensboro, N. C. (42). **E**
Buckingham, Chas. L., 195 Broadway, New York, N. Y. (28).
Buffum, Prof. Burt C., State Univ., Laramie, Wyo. (42). **G**
Bull, Prof. Storm, Madison, Wis. (44). **D**
Burke, Arthur N., A.B., Principal of Monson Academy, Monson, Mass. (44).
Burr, Mrs. Laura E., Commercial Hotel, Lansing, Mich. (34). **B**
Burt, Milo Cudworth, Amherst, Mass. (44). **C**
Burwell, Arthur W., Ph.D., 208 Superior St., Cleveland, Ohio (37).

Calkins, Dr. Marshall, Springfield, Mass. (29).
Cannon, George L., jr., High School, Denver, Col. (39). **F H**
Card, Fred W., Prof. of Horticulture, Univ. of Nebraska, Lincoln, Neb. (45).
Carpenter, Mrs. Benjamin, 50 Cedar St., Chicago, Ill. (41). **H**
Carpenter, Ford A., U. S. Weather Bureau, San Diego, Cal. (44). **B**
Carpenter, Geo. O., jr., care St. Louis Lead and Oil Co., St. Louis, Mo. (29).
CARTER, JAMES C., 277 Lexington Ave., New York, N. Y. (36).
Carter, John E., Knox and Coulter Sts., Germantown, Pa. (33). **B H**
Cary, Albert A., 28 Cliff St., New York, N. Y. (36). **D**

Cary, Mrs. Elizabeth M. L., Buffalo, N. Y. (45). **E**
Chadbourn, Erlon R., Lewiston, Me. (29).
Chase, Frederick L., Yale Univ. Observ., New Haven, Conn. (43).
Chase, R. Stuart, 53 Summer St., Haverhill, Mass. (18). **F**
Chester, Commander Colby M., U. S. N., U. S. Naval Academy, Annapolis, Md. (28). **E**
Child, C. D., Ithaca, N. Y. (44). **B**
Christian, Ira W., Noblesville, Ind. (39).
Chrystie, Wm. F., Hastings-on-Hudson, New York, N. Y. (36).
Church, Royal Tyler, Turin, Lewis Co., N. Y. (38). **D F**
Clancy, Michael Albert, 1426 Corcoran St., Washington, D. C. (40). **H**
Clapp, Geo. H., 116 Water St., Pittsburg, Pa. (33). **H C**
Clark, Alex. S., Westfield, N. J. (33).
Clark, Edward, 417 Fourth St., Washington, D. C. (40).
Clarke, John Mason, Ass't State Geol. and Paleontologist of N. Y., State Hall, Albany, N. Y. (45). **E**
Clark, Joseph E., M.D., 184 Clinton St., Brooklyn, N. Y. (43). **A E**
Clark, Oliver Durfee, 590 Halsey St., Brooklyn, N. Y. (41). **F E**
Clark, S. Wellman, M.D., 110 Mercer St., Jersey City, N. J. (44). **H**
Clarke, Sherman, 805 Wilder Building, Rochester, N. Y. (41). **C**
Clark, Thomas H., 22 Lancaster St., Worcester, Mass. (40).
Clark, Wm. Brewster, M.D., 50 E. 31st St., New York, N. Y. (33). **F C**
Clough, Albert L., S. B., Box 14, Manchester, N. H. (45). **B**
Cluett, J. W. Alfred, Troy, N. Y. (43).
Cobleigh, Wm. Merriam, E.M., Bozeman, Mont. (45). **C**
Cochran, C. B., Food Inspector to State Board of Agric., 514 South High St., West Chester, Chester Co., Pa. (43). **C**
COE, HENRY W., M.D., Oregonian Building, Portland, Oregon (32). **H F**
Coffin, Amory, Phœnixville, Chester Co., Pa. (31). **D**
Coit, J. Milner, Ph.D., Saint Paul's School, Concord, N. H. (33). **B C E**
Colgate, Abner W., Morristown, N. J. (44).
Colie, Edw. M., East Orange, N. J. (30). **E I**
Collie, Prof. Geo. L., Beloit College, Beloit, Wis. (42). **E**
Collin, Rev. Henry P., Coldwater, Mich. (37). **F**
Colton, Buel P., Normal, McLean Co., Ill. (34). **F**
Comstock, Dr. T. Griswold, 3401 Washington Ave., St. Louis, Mo. (29). **F H**
Conant, Miss E. Ida, 42 West 48th St., New York, N. Y. (33). **H I F**
Conklin, Prof. Roland E., A.M., Eureka College, Eureka, Ill. (42). **F**
Cook, Dr. Charles D., 133 Pacific St., Brooklyn, N. Y. (25).
Cook, Melville T., Greencastle, Ind. (45). **G**
Coon, Henry C., M.D., Alfred Univ., Alfred Centre, N. Y. (29). **B C F**
Cope, Thos. P., Awbury, Germantown, Pa. (33). **I**
Copeland, Edwin Bingham, Monroe, Wis. (45). **G**
Coquillett, Daniel William, Dep't of Agric., Washington, D. C. (43). **F**
Corbitt, James H., University of Virginia, Charlottesville, Va. (44).
Corcoran, Dr. Luke, Maple St., Springfield, Mass. (44). **H**

Cowell, Jno. F., Buffalo, N. Y. (35).
Cowles, Alfred H., 656 Prospect St., Cleveland, Ohio (37). **B C**
Cowles, James Lewis, Farmington, Conn. (44).
Cox, Charles F., Pres. Council Scientific Alliance of New York, Grand Central Depot, New York, N. Y. (43).
Crafts, Robert H., 2329 So. 6th St., Minneapolis, Minn. (32). **I B**
Craig, John, Horticulturist, Experimental Farms, Ottawa, Ontario, Can. (41).
Crawford, John, Leon, Nicaragua, C. A. (40). **E H**
Crawley, Edwin S., Ph.D., Springfield Ave., Chestnut Hill, Philadelphia, Pa. (45).
Crehore, Mary L., care Wm. W. Crehore, Hackensack, N. J. (43). **B**
CROWELL, A. F., Woods Holl, Mass. (30). **C**
Cruikshank, James, LL.D., 206 So. Oxford St., Brooklyn, N. Y. (36).
Cunningham, Francis A., 1613 Wallace St., Philadelphia, Pa. (33). **D E B**
Cunningham, Prof. Susan J., Swarthmore College, Swarthmore, Pa. (38). **A**
Cuntz, Johannes H., 325 Hudson St., Hoboken, N. J. (36).
Curtis, William E., Post Building, Washington, D. C. (40). **H I**
Cutler, Dr. Andrew S., Kankakee, Ill. (32). **I E**

DALY, HON. CHARLES P., 84 Clinton Place, New York, N. Y. (36). **E H**
Daniells, Prof. William W., Univ. of Wis., Madison, Wis. (42). **C**
Davenport, Prof. Eugene, Dean of the Coll. of Agric., Univ. of Ill., Champaign, Ill. (39).
Davidson, R. J., Experiment Station, Blacksburgh, Va. (40). **C**
Davis, Abial B., A.M., 129 East Lincoln Ave., Mt. Vernon, N. Y. (44). **A**
Davis, Bradley Moore, Dep't of Botany, Univ. of Chicago, Chicago, Ill. (45). **G**
Davis, G. C., Agricultural College, Mich. (43).
Davis, J. C. Bancroft, 1621 H St., N. W., Washington, D. C. (40).
Davis, J. J., M.D., 1119 College Ave., Racine, Wis. (31). **F G**
Davison, John M., 60 Oxford St., Rochester, N. Y. (38). **C**
Dean, Seth, Glenwood, Iowa (34). **D**
Deane, Walter, 29 Brewster St., Cambridge, Mass. (44).
DeCourcy, Bolton Waller, 911 North 10th St., Tacoma, Washington (41). **I D**
Deeds, Edward A., Denison Univ., Granville, Ohio (45). **B**
DeForest, Henry S. (32). **H I**
Deghuée, Joseph A., 247 Harrison St., Brooklyn, N. Y. (40). **C**
Delafield, Maturin L., jr., Fieldston, Riverdale, New York, N. Y. (43). **G**
Densmore, Prof. H. D., Beloit, Wis. (41). **G**
Dewey, L. H., Dept. of Agric., Washington, D. C. (40). **F**
Dittenhoefer, A. J., 96 Broadway, New York, N. Y. (36).
Dodge, Charles Wright, M.S., University of Rochester, Rochester, N. Y. (39). **F**
Dodge, Melvin Gilbert, Hamilton College, Clinton, N. Y. (42). **C**
Dodge, Philip T., Tribune Building, New York, N. Y. (44). **B D**

Dodge, Wm. C., 116 B St., N. E., Washington, D. C. (40). **H**
Doty, P. A., 211 Park Ave., Paterson, N. J. (43). **D**
Doubleday, H. H., 715 H St., N.W., Washington, D. C. (40). **H**
Doughty, John W., 165 Johnston St., Newburgh, N. Y. (19). **E**
Dow, Mrs. Frederick C., North Elm St., Manchester, N. H. (42). **E F G H**
Drescher, Willibald A. E., P. O. Drawer 1033, Rochester, N. Y. (41). **F**
Drummond, Isaac Wyman, Ph.D., 436 W. 22nd St., New York, N.Y. (36).
Dryer, Chas. R., Fort Wayne, Ind. (38). **E**
Dudek, Miss Katie M., 54 W. 55th St., New York, N. Y. (36). **E**
Duffy, Rev. James S.; 474 Sackett St., Brooklyn, N. Y. (43).
Duggar, Benjamin Minge, Cornell Univ., Ithaca, N. Y. (45).
Du Prè, Prof. Daniel A., Wofford College, Spartanburg, S. C. (28). **B C E**
Durand, Elias J., Ithaca, N. Y. (41). **F**
Durfee, W. F., Birdsboro, Berks Co., Pa. (33). **D C B A E I**
Dyar, Harrison G., A.M., Ph.D., 243 W. 99th St., New York, N. Y. (43).
Dyer, Clarence M., Lawrence, Mass. (22).

Edelheim, Carl, 253–259 N. Broad St., Philadelphia, Pa. (33).
Edson, Hubert, Patterson, La. (40).
Edwards, J. W., P. O. Box 282, Rico, Col. (32).
Edwards, W. F., 535 Boylston St., Seattle, Wash. (33). **B C**
Ekeley, Prof. John B., The Cathedral School of Saint Paul, Garden City, L. I. (42). **C**
Ellms, Joseph Wilton, Framingham Center, Mass. (44). **C**
Elmer, Howard N., St. Paul, Minn. (32). **D I**
Emery, Frank E., No. Caro. Experiment Station, Agric. and Mechan. Coll., Raleigh, N. C. (38). **F**
English, Geo. L., 733 Broadway, New York, N. Y. (36).
Estes, Dana, Brookline, Mass. (29). **I H**
Evans, Alexander W., M.D., 12 High St., New Haven, Conn. (45) **G**
Evans, Samuel G., 211 Main St., Evansville, Ind. (39). **F**
Evers, Edward, M.D., 1861 North Market St., St. Louis, Mo. (28). **F H**
Ewell, Marshall D., M.D., Rooms 613 and 614, Ashland Block, 59 Clark St., Chicago, Ill. (40).

Fairchild, B. T., P. O. Box 1120, New York, N. Y. (36).
Fairchild, Gen. Lucius, 302 Monona Ave., Madison, Wis. (42). **I**
Fairfield, W. B., U. S. C. and G. Survey, Washington, D. C. (40). **E**
Falconer, Wm., Glen Cove, Queens Co., N. Y. (29).
Fearey, Thomas Healey, 901 D. S. Morgan Building, Buffalo, N. Y. (45). **B**
Felt, Ephraim Porter, Northboro, Mass. (44). **F**
Fernald, F. A., 72 Fifth Ave., New York, N. Y. (43). **C**
Fireman, Peter, Ph.D., The Columbian Univ., Washington, D. C. (45).
Fischer, E. G., U. S. Coast and Geodetic Survey, Washington, D. C. (40). **A**
Fisher, Geo. E., 37 and 39 Wall St., New York, N. Y. (37).

Flanders, Charles S., Franklin, Mass. (42). **E**
Fletcher, C. R., 82 Equitable Building, Boston, Mass. (29). **C E**
Floody, Rev. Robert John, Sc.M., S.T.B., South Ashburnham, Mass. (44). **H**
Focke, Theodore M., 80 So. Professor St., Oberlin, Ohio (44). **B**
Forwood, Dr. W. H., Soldiers' Home, Washington, D. C. (40).
Frankforter, Prof. Geo. B., The Univ. of Minnesota, Minneapolis, Minn. (43). **C**
Freeman, Prof. T. J. A., Woodstock Coll., Howard Co., Md. (33). **B C**
Freley, Prof. Jasper Warren, Wells Coll., Aurora, Cayuga Co., N. Y. (45). **B E**
Frick, Prof. John H., Central Wesleyan Coll., Warrenton, Mo. (27). **E F B A**
Fries, Dr. Harold H., 92 Reade St., New York, N. Y. (40). **C**
Frisbie, J. F., M.D., Box 455, Newton, Mass. (29). **E H**
FROTHINGHAM, MRS. LOIS R., Milton, Mass. (31). **F A I**
Fuller, Chas. G., M.D., 38 Central Music Hall, Chicago, Ill. (35). **F**
Fuller, Levi K., Brattleboro, Vt. (34). **D A**
Fuller, Melville W., LL.D., Chief Justice U. S., 1800 Mass. Ave., Washington, D. C. (40).
Furbish, Miss Kate, 13 Lincoln St., Brunswick, Me. (44). **G**

Gable, George D., Ph.D., Lafayette College, Easton, Pa. (40). **A B**
Galloway, Prof. Thomas Walton, Missouri Valley Coll., Marshall, Mo. (45). **F G**
Gardner, Rev. Corliss B., Ripley, N. Y. (29). **A B I**
GARLAND, JAMES, 2 Wall St., New York, N. Y. (36).
Garman, Harrison, Lexington, Ky. (38).
Garnett, Algernon S., M.D., Hot Springs, Ark. (23).
Garnier, Madame Laure Russell, 116 W. 59th St., New York, N. Y. (40).
Gates, Nelson J., 1141 Dean St., Brooklyn, N. Y. (43).
Gault, Franklin B., Univ. of Idaho, Moscow, Idaho (43).
Gause, Frederick T., 128 Pearl St., New York, N. Y. (40).
Gay, Miss E. J., 214 1st St., S. E., Washington, D. C. (44). **H**
GENTH, FRED. A., Lansdowne, Del. Co., Pa. (32). **C E**
Georgeson, Charles C., M.Sc., Manhattan, Kan. (42). **I**
Gerrodette, Frank Honoré, Columbia Univ., New York, N. Y. (45). **H E I**
Getman, Frederick H., 196 Atlantic St., Stamford, Conn. (45). **B**
Gibbons, John T., M.D., U. S. N., 1297 Bushwick Ave., Brooklyn, N. Y. (43). **E**
Gilson, George Fredom, Pleasanton, Alameda Co., Cal. (41). **H**
GLENNY, WILLIAM H., JR., Buffalo, N. Y. (25).
Golden, Miss Katherine E., Lafayette, Ind. (42). **G**
Goldsborough, W. E., M.E., 164 Columbia St., Lafayette, Ind. (44). **D**
Goodnow, Henry R., 95 Riverside Drive, New York, N. Y. (32). **B**
Goodridge, E. A., M.D., 85 Maine St., Flushing, N. Y. (36).
Goodyear, William H., 222 E. 69th St., New York, N. Y. (43).

Gottlieb, J. Adelphi, A.M., M.D., Sc.D., 304 W. 104th St., New York, N. Y. (43). **C E F G H I**

Gould, Sylvester C., Manchester, N. H. (22). **A B E H**

Grabau, Amadeus W., S.B., Mass. Inst. Technology, Boston, Mass. (45).

Graef, Edw. L., 58 Court St., Brooklyn, N. Y. (28). **F**

Graf, Louis, Van Buren, Crawford Co., Ark. (30). **E F H**

Green, Edgar Moore, M.D., Easton, Pa. (36).

Greene, Prof. Edward Lee, Univ. of Cal., Berkeley, Cal. (42). **G**

Greene, G. K., 195 West 1st St., New Albany, Ind. (38).

Greene, Jacob L., Pres. Mut. Life Ins. Co., Hartford, Conn. (28).

Greene, Jeannette B., M.D., Sci.D., F.E.C., 56 W. 55th St., New York, N. Y. (33). **F E C**

Green, Milbrey, M.D., 567 Columbus Ave., Boston, Mass. (29).

Greenleaf, John T., Owego, N. Y. (33). **F**

Greenleaf. R. P., M.D., 803 Market St., Wilmington, Del. (31). **B F**

Greve, Theodor L. A., M.D., 260 W. 8th St., Cincinnati, Ohio (30).

Griscom, Wm. W., Haverford College P. O., Pa. (33). **B C D**

Grower, George G., Ansonia, Conn. (43). **B D**

Gruener, Hippolyte, Adelbert College, Cleveland, Ohio (44).

Gulliver, F. P., Norwich, Conn. (40). **E**

Gunckel, Lewis W., care The Seybold Machine Co., Dayton, Ohio (41). **H**

Gurley, Wm. F. E., Danville, Vermilion Co., Ill. (37). **E**

Guthe, Karl E., Ph.D., Instructor in Physics at the Univ. of Mich., 36 Kingsley St., Ann Arbor, Mich. (45). **B D**

Hacker, William, General Offices, Penn. R. R. Co., Philadelphia, Pa. (33). **F E**

Hagemann, John, 125 Rusk St., Houston, Texas (29). **C**

Hagar, Stansbury, 372 Washington Ave., Brooklyn, N. Y. (43).

Haight, Stephen S., C.E., 1266 Clover St., West Farms, New York, N. Y. (31). **D**

Hale, George D., 5 Gibbs St., Rochester, N. Y. (41).

Hall, James P., 6 Poplar St., Brooklyn, N. Y. (40). **A B**

Hall, Winfield S , M.D., Northwestern Univ. Medical School, 2421-2431 Dearborn St., Chicago, Ill. (40).

Halstead, D. B., 335 Washington Ave., Brooklyn, N. Y. (43).

Hammon, W. H., Forecast Official, Weather Bureau, San Francisco, Cal. (37). **B**

Harmon, Miss A. Maria, 189 Maclaren St., Ottawa, Ontario, Can. (31). **H F**

Harper, Henry Winston, M.D., Univ. of Texas, Austin, Texas (45). **C**

Harrington, Prof. Mark W., Pres. Univ. of Washington, Seattle, Wash. (40). **B**

Harris, Prof. Elmo G., Missouri School of Mines, Rolla, Mo. (43).

Harris, Miss Emma G., Woonsocket, R. I. (44). **H F E**

Harris, I. H., Waynesville, Warren Co., Ohio (30). **E H**

Harris, Mrs. Robert, Buckingham Hotel, New York, N. Y. (36).

Harrison, Caleb N., 1010 N. Arlington Ave., Baltimore, Md. (42). **A B**

Harrison, Miss Carrie, 1413 N St., N. W., Washington, D. C. (42). **G**
Harrison, Edwin, 520 Olive St., Room 620, St. Louis, Mo. (11). **E**
Hart, C. Porter, M.D., Wyoming, Hamilton Co., Ohio (30). **F**
Hart, Rev. Prof. Samuel, Trinity College, Hartford, Conn. (22). **A**
Hartz, J. D. Aug., College Point, N. Y. (43).
Harvey, A. F., Kirkwood, Mo. (40).
Hathaway, Nath'l, New Bedford, Mass. (30). **C**
Haven, Franklin, jr., New England Trust Co., Boston, Mass. (29).
Hays, Joseph A., Ph.G., 147 So. 18th St., Pittsburgh, Pa. (44). **B C G H**
Hays, Prof. Willet M., Saint Anthony Park, Saint Paul, Minn. (45).
Haywood, Prof. John, Otterbein Univ., Westerville, Ohio (30). **A B**
Head, W. R., 5467 Jefferson Ave., Hyde Park, Chicago, Ill. (38). **E**
Hedge, Fred. H., Public Library, Lawrence, Mass. (28). **F H**
Hedrick, Henry B., A.B., Nautical Almanac Office, Washington, D. C. (40).
Henderson, Mrs. Alice Palmer, 2301 Clinton Ave., Minneapolis, Minn. (42). **H**
Hendricks, Henry H., 49 Cliff St., New York, N. Y. (30).
Henry, Chas. C., M.D., 56 Clark St., Brooklyn, N. Y. (43).
Hershey, Oscar H., Galena, Stone Co., Mo. (42). **E**
Hertzberg, Prof. Constantine, 181 S. Oxford St., Brooklyn, N. Y. (29). **B F**
HEXAMER, C. JOHN, C.E., 419 Walnut St., Philadelphia, Pa. (33). **C B**
Heyer, Wm. D., 16 South Reid St., Elizabeth, N. J. (33). **B D**
Hice, Richard R., Beaver, Beaver Co., Pa. (41). **E**
Hicks, Gilbert H., 2221 15th St., N. W , Washington, D. C. (43).
Higbee, H. H., Johns Hopkins Univ., Baltimore, Md. (43).
Higley, Warren, 120 Broadway, New York, N. Y. (43).
Hill, John Edward, Brown Univ., Providence, R. I. (44). **D**
Hinton, John H., M.D., 41 West 32nd St., New York, N. Y. (29). **F H**
Hitchcock, Miss Fannie R. M., 300 William St., E. Orange, N. J. (35). **F**
Hoadley, Geo. A., A.M., Swarthmore College, Swarthmore, Pa. (40).
Hobbs, Prof. Perry L., Western Reserve Medical College, Cleveland, Ohio (41). **C**
Hodge, J. M., Big Stone Gap, Va. (29). **D E**
Hodges, Julia, 139 W. 41st St., New York. N. Y. (36). **E F H**
Hodskins, Miss G. A., Springfield, Mass. (44). **F G**
HOE, MRS. R., JR., 11 E. 36th St., New York, N. Y. (36).
Hoe, Mrs. Richard M., 11 E. 71st St., New York, N. Y. (36).
Hoeltge, Dr. A., 322 Lime St., Cincinnati, Ohio (30).
Hoffman, The Rev. Eugene Aug., D.D., Dean of Gen. Theol. Seminary, 426 W. 23d St., New York, N. Y. (36).
Holden, E. F., 530 W. Onondaga St., Syracuse, N. Y. (43). **A**
Holden, L. E., The Hollenden, Cleveland, Ohio (32).
HOLDEN, MRS. L. E., The Hollenden, Cleveland, Ohio (35).
Holley, George W., Ithaca, N. Y. (19). **B I**
Hollingsworth, Jno. E., Austin, Texas (40).
Hollinshead, Warren H , Vanderbilt Univ., Nashville, Tenn. (37).

Holmes, W. Newton, Pritchett School Inst., Glasgow, Mo. (36).
Holstein, Geo. Wolf, Albany, Shackelford Co., Texas (28). **E H**
Holt, Henry, 29 West 23d St., New York, N. Y. (29).
Holton, Henry D., Brattleboro, Vt. (44). **I**
Homburg, Frederick, 40 Clifton Ave., Cincinnati, Ohio (39). **C**
Homer, Chas. S., jr., of Valentine & Co., 245 Broadway, New York, N. Y., (29).
Hood, Gilbert E., Lawrence, Mass. (29). **H E B**
Hood, William, 512 Van Ness Ave., San Francisco, Cal. (35). **D**
Hooker, Prof. Henrietta E., Mt. Holyoke Coll., South Hadley, Mass. (45) **G**
Hooper, Prof. Franklin W., Curator Brooklyn Inst., Brooklyn, N. Y. (43).
Hopkins, A. D., Exper. Station, Morgantown, W. Va. (42). **F**
Hopkins, Prof. A. J., Amherst College, Amherst, Mass. (44). **C**
Hopkins, Grant S., Ithaca, N. Y. (41). **F**
Hopkins, Thos. C., Geologist, State College, Centre Co., Pa. (38). **E**
Horr, Asa, M.D., 1311 Main St., Dubuque, Iowa (21). **B E**
Horsford, Miss Cornelia, 27 Craigie St., Cambridge, Mass. (43). **H**
Hoskins, William, La Grange, Cook Co., Ill. (34). **C**
Hotchkiss, Homer J., Cornell Univ., Ithaca, N. Y. (45). **B**
Hough, Romeyn B., Lowville, N. Y. (37).
Howe, Lucien, M.D., 183 Delaware Ave., cor. Huron St., Buffalo, N. Y. (45).
Hoyt, James T., Temple Court, Beekman St., New York, N. Y. (38). **A H**
Hudson, George H., Plattsburgh, Clinton Co., N. Y. (31). **F**
Hume, Alfred, C. E., University, Miss. (39). **A**
Humphrey, Daniel, M.D., Lawrence, Mass. (18). **F H**
Humphrey, James Ellis, Johns Hopkins Univ., Baltimore, Md. (44). **G**
Hungerford, W. S., care W. Ames & Co., Jersey City, N. J. (43). **D**
Hunt, J. H , M.D., 1085 Bedford Ave., Brooklyn, N. Y. (43).
Hunt, Richard M., Metropolitan Building, 1 Madison Ave., New York, N. Y. (36).
Hunt, Miss Sarah E., Salem, Mass. (20).
Hunter, Prof. Joseph Rufus, Richmond Coll., Richmond, Va. (45). **C**
Huntington, Elon, 762 N. St. Paul St., Rochester, N. Y. (41). **B E**
Huntington, F. W., Montclair, N. J. (45). **B**
Hurd, E. O., Plainville, Hamilton Co., Ohio (30). **E F**
Hutchinson, Wm. M., M.D., 207 Clinton St., Brooklyn, N. Y. (40). **C B**
Hyde, B. T. B., 20 W. 53d St., New York, N. Y. (43). **D**
Hyde, E. Francis, 522 Fifth Ave., New York, N. Y. (43). **A**
Hyde, Frederick E., M.D., 20 W. 53d St., New York, N. Y. (43). **E**
Hyde, Frederick E., jr., 20 W. 53d St., New York, N. Y. (43). **H**

ILES, GEORGE, 5 Brunswick St., Montreal, Can. (31). **I**
Ingham, Wm. A., 320 Walnut St., Philadelphia, Pa. (33). **E I**
Innes, Murray, care O. D. Copper Mining Co., Globe, Arizona (45).

Irwell, Lawrence, 76 West Tupper St., Buffalo, N. Y. (45). **F**
Ives, Frederick E., 2750 N. 11th St., Philadelphia, Pa. (44). **B**
Ives, James T. B., Philadelphia, Pa. (43). **E**

James, Bushrod W., M.D., N. E. cor. 18th and Green Sts., Philadelphia, Pa. (29). **F**
James, Darwin R., 226 Gates Ave., Brooklyn, N. Y. (43).
James, Mrs. Darwin R., 226 Gates Ave., Brooklyn, N. Y. (43).
James, Davis L., 131 West 7th St., Cincinnati, Ohio (30). **F**
Jefferis, Wm. W., 1836 Green St., Philadelphia, Pa. (33). **E**
Jenks, Wm. H., Brookville, Pa. (38).
Jenner, Charles H., Prof. of Natural and Applied Sciences, Brockport, N. Y. (41). **A B D**
Jennings, Walter L., 900 Beacon St., Boston, Mass. (45).
Jesunofsky, Lewis N., U. S. Weather Bureau, Charleston, S. C. (36). **B**
Jewett, Dr. Frederic A., 282 Hancock St., Brooklyn, N. Y. (43).
Johnson, Henry Clark, 27 and 29 Pine St., New York, N. Y. (42). **I**
Johnson, Dr. Henry L. E., 1400 L St., N. W., Washington, D. C. (40). **F**
Johnson, Lorenzo N., Boulder, Col. (39). **F**
Johnson, Nels, Manistee, Mich. (41). **A B**
Johnson, Roswell Hill, 234 Highland Ave., Buffalo, N. Y. (44). **F H G**
Jones, Prof. Forrest R., Univ. of Wisconsin, Madison, Wis. (42). **D**
Jones, Prof. Frederick S., The Univ. of Minnesota, Minneapolis, Minn. (45).
Jones, Paul M., D.Sc., Nashville, Tenn. (40). **E F**
Jordan, Whitman H., Director N. Y. Agric. Exper. Station, Geneva, N. Y. (45).

Kedzie, John H., Evanston, Ill. (34). **B**
Keeler, Aaron Benedict, 70 N. Pearl St., Buffalo, N. Y. (45) **I**
Keep, Wm. J., Detroit, Mich. (37).
Keith, Walter J., Ph.D., State College, Pa. (44). **C**
Kelley, Henry S., 208 Wooster St., New Haven, Conn. (36). **D C**
Kelley, John Harris, Bentonville, Ark. (44). **C**
Kellogg, David S., M.D., Plattsburgh, N. Y. (29). **H**
Kellogg, John H , M.D., Battle Creek, Mich. (24). **F**
Kendrick, Prof. Arthur, Rose Polytechnic Inst., Terre Haute, Ind. (45). **B**
Kennedy, Dr. George Golding, Roxbury, Mass. (40). **F**
KENNEDY, HARRIS, 284 Warren St., Roxbury, Mass. (40). **E F**
Kern, Josiah Quincy, Ph.D., P. O. Box 265, Treasury Dept., Washington, D. C. (40). **I**
Kinder, Miss Sarah A., 28 Lockerbie St., Indianapolis, Ind. (39). **H**
King, A. F. A., M.D., 1315 Mass. Ave., N. W., Washington, D. C. (29). **F H**
King, Miss Ada M., 8 Briggs Place, Rochester, N. Y. (39). **E I**
King, Miss Harriet M., Salem, Mass. (28).
Kingsbury, Prof. Albert, Durham, N. H. (43). **D**

Kingsbury, Benj. F., Ithaca, N. Y. (45). **F**
Kinner, Hugo, M.D., 1517 South Seventh St., St. Louis, Mo. (21). **F H**
Kirkpatrick, Walter G., 2102 West End Ave., Nashville, Tenn. (41).
Kittredge, Miss H. A., North Andover, Mass. (37). **F**
Klie, G. H. Carl, M.D., 5100 No. Broadway, St. Louis, Mo. (39). **C F**
Kneeland, Stillman F., LL.D., 110 Berkeley Pl., Brooklyn, N. Y. (43). **I**
Knight, Chas. H., M.D., 20 W. 31st St., New York, N. Y. (36).
Knight, Prof. Charles M., 219 So. Union St., Akron, Ohio (29). **C B**
Knox, Wilm, Society for Savings Building, Cleveland, Ohio (38).
Koons, B. F., Storrs, Conn. (43).
Kost, John, LL.D., Adrian, Mich. (34). **E**
Koues, Miss Elizabeth L., The Cathedral School of Saint Mary, Garden City, N. Y. (41). **I**
Krécsy, Prof. Béla, Györ, Hungary (41). **C**
Kuhne, F. W., 19 Court St., Fort Wayne, Ind. (38). **A F**

Ladd, G. E., Bradford, Mass. (39). **E**
La Forge, Lawrence, Alfred Univ. Observ., Alfred, N. Y. (43).
Lambert, Preston A., 215 S. Center St., Bethlehem, Pa. (41). **A**
Lampard, Henry, 102 Shuter St., Montreal, Can. (40). **C D E**
LANDERO, CARLOS F. DE, Ass't Director, Pachuca and Real del Monte Mining Co., Pachuca, Mexico (36). **C B**
Lang, Prof. Henry R., Yale Univ., New Haven, Conn. (41). **H**
Langmann, Gustav, M.D., 115 W. 57th St., New York, N. Y. (36).
Lasché, Alfred (39). **C F G**
Latham, Woodville, 32 E. 21st St., New York, N. Y. (43).
Law, Benedict W., Pasadena, Cal. (45). **E**
Lawrance, J. P. S., Past Ass't Engineer, U. S. N., Navy Yard, Norfolk, Va. (35). **D**
Lawrence, Harry E., Rochester Univ., Rochester, N. Y. (44). **B**
Laws, Miss Annie, 100 Dayton St., Cincinnati, Ohio (30). **I**
Leavitt, R. G., Easthampton, Mass. (44). **B**
Lee, Mrs. William, 1382 Beacon St., Boston, Mass. (36).
Leeds, James S., 109 Produce Exchange, New York, N. Y. (41).
Leiter, L. Z., 81 South Clark St., Chicago, Ill. (40).
Lemp, William J., cor. Cherokee and 2nd Carondelet Avenue, St. Louis, Mo. (27).
Leslie, Geo. L., Prin. High School, Rock Island, Ill. (40).
Lewis, Geo. S., jr., Springfield, Mass. (44). **G**
Lewis, Joseph Volney, Prof. of Geol. and Mineral., Clemson College, S.C. (45). **E C**
Lewis, Wm. J., M.D., 145 W. 43d St., New York, N. Y. (33). **F E**
Lincoln, Prof. David F., M.D., 18 Sidney Place, Brooklyn, N. Y. (41).
Lindenkohl, Adolphus, U. S. Coast and Geodetic Survey, Washington, D. C. (40). **E**
Lindsay, Alexander M., Rochester, N. Y. (41).
Livermore, Mrs. M. A. C., 1569 Mass. Ave., Cambridge, Mass. (29). **F**

Loeser, Gustav, Fulton St., opp. De Kalb Ave., Brooklyn, N. Y. (43).
Loewy, Benno, 206 and 208 Broadway, New York, N. Y. (41).
Logan, F. G., 2919 Prairie Ave., Chicago, Ill. (42). **H**
Logan, Walter S., 58 William St., New York, N. Y. (36).
Lomb, Adolph, P. O. Drawer 1033, Rochester, N. Y. (41).
Lomb, Henry, P. O. Drawer 1033, Rochester, N. Y. (41).
Lomb, Henry C., P. O. Drawer 1033, Rochester, N. Y. (43).
Lonsdale, Elston H., Ass't Missouri Geol. Survey, Jefferson City, Mo. (41). **E**
Lord, Benjamin, 34 W. 28th St., New York, N. Y. (36).
Lord, Prof. H. C., Ohio State Univ., Columbus, Ohio (44). **A**
Lovejoy, Frederick W., 348 Hancock St., Brooklyn, N. Y. (43).
Low, A. A., Columbia Heights, Brooklyn, N. Y. (43). **A**
Lowell, Aug., 60 State St., Boston, Mass. (29).
Lowman, John H., M.D., 345 Prospect St., Cleveland, Ohio (37).
Ludlow, Wm., Lt. Col. U. S. A., care War Dep't, Washington, D. C. (33). **D B**
Lufkin, Albert, Newton, Iowa (31). **D E**
Lull, Richard S., Amherst, Mass. (43). **F H**
Lund, James, 142 Hawthorne St., Malden, Mass. (45).
LYMAN, BENJ. SMITH, 708 Locust St., Philadelphia, Pa. (15). **E**
Lyman, Henry H., 74 McTavish St., Montreal, P. Q., Can. (29). **F E**
Lyon, Edmund, 110 So. Fitzhugh St., Rochester, N. Y. (41).

MacArthur, Charles L., Troy, N. Y. (39).
McCammon, Gen. Joseph K., 1420 F St., Washington, D. C. (40).
McCartney, Dr. James H., 138 East Main St., Rochester, N. Y. (41). **B**
McClintock, A. H., Wilkes Barre, Pa. (33). **H**
McClintock, Frank, Grand Junction, Col. (43). **A B D**
McCormick, L. M., Curator Glen Island Mus. Nat. Hist., Glen Island, N. Y. (43).
McCulloch, Champe Carter, jr., Ph.D., M.D., Fort Ringgold, Texas (39). **E**
Mac Dougal, Daniel T., Univ. of Minnesota, Minneapolis, Minn. (44). **G**
McFadden, Prof. L. H., Westerville, Ohio (32). **B C**
McFarland, Robert W., LL.D., Oxford, Ohio (33). **A**
McGee, Miss Emma R., Farley, Iowa (33). **H**
McGiffert, James, 169 8th St., Troy, N. Y. (44). **A**
MacGregory, A. C., 36 Fremont St., Springfield, Mass. (43).
McHenry, Prof. B. F., Union Christian College, Merom, Ind. (39). **A E**
McLean, T. C., Lieut. U. S. N., New Hartford, Oneida Co., N. Y. (33).
McMillan, Smith B., Signal, Columbiana Co., Ohio (37).
McMillin, Emerson, 40 Wall St., New York, N. Y. (37).
McPherson, Prof. Wm., Ohio State Univ., Columbus, Ohio (45). **C**
McWilliams, D. W., 39 So. Portland Ave., Brooklyn, N. Y. (43).
Macdougall, Alan, 32 Adelaide St. East, Toronto, Ontario, Can. (38). **D H**
Macfarlane, Dr. John M., Lansdowne, Del. Co., Pa. (41). **F**

Magruder, Wm. T., Ohio State Univ., Columbus, Ohio (37).
Mallinckrodt, Edw., P. O. Sub-station A, St. Louis, Mo. (29). **C**
Malone, Rev. Sylvester, 69 So. 3d St., Brooklyn, N. Y. (43).
Mann, Abram S., Rochester, N. Y. (39). **E**
Mann, Albert, Ph.D., Ohio Wesleyan Univ., Delaware, Ohio (43). **F G**
Mann, Thomas Wm., 35 Hampden St., Holyoke, Mass. (44). **D**
Manning, Charles H., U. S. N., Manchester, N. H. (35). **D**
Manning, Warren H., Brookline, Mass. (31). **F H E**
Mapes, Charles Victor, 60 W. 40th St., New York, N. Y. (37). **C**
MARBLE, MANTON, 532 Fifth Ave., New York, N. Y. (36).
Marble, J. Russel, Worcester, Mass. (31). **C E**
Marble, Miss Sarah, Woonsocket, R. I. (29). **C**
Marindin, Henry Louis, U. S. Coast and Geodetic Survey, Washington, D. C. (40). **E**
Markley, Joseph L., Ph.D., 50 Thompson St., Ann Arbor, Mich. (40).
Marple, Charles A., 717 W. Chestnut St., Louisville, Ky. (39). **B**
Marsden, Samuel, 1015 North Leffenwell Ave., St. Louis, Mo. (27). **A D**
Mateer, Horace N., M.D., Wooster, Wayne Co., Ohio (36). **F E**
Mathews, Miss Mary Elizabeth, Lake Erie Seminary, Painesville, Ohio (41). **F**
Mattison, Joseph G., 20 West 14th St., New York, N. Y. (30). **C**
Mattoon, Laura I., Springfield, Mass. (44). **F**
Maxwell, Henry W., 70 First Place, Brooklyn, N. Y. (43).
Maynard, Geo. C., 1227 19th St., Washington, D C. (35). **B D**
Maynard, Prof. Samuel T., Agricultural College, Amherst, Mass. (38).
Maynard, Washburn, Lieut. Com'd U. S. N., Bureau of Ordnance, Navy Dep't, Washington, D. C. (33). **B**
Means, John H., Cal. State Mining Bureau, 24 Fourth St., San Francisco, Cal. (38). **E**
Meeds, Alonzo D., Univ. of Minnesota, Minneapolis, Minn. (42).
Meehan, Mrs. Thos., Germantown, Pa. (29).
Mellor, Chas. C., 77 Fifth Ave., Pittsburgh, Pa. (38).
Merrick, Hon. Edwin T., P. O. Box 606, New Orleans, La. (29). **E A**
Merrill, Miss Harriet Bell, 449 Marshall St., Milwaukee, Wis. (43). **F**
Merrill, Mrs. Winifred Edgerton, Ph.D., 2 Sprague Place, Albany, N. Y. (35). **A**
Merrow, Miss Harriet L., Kingston, R. I. (44).
Merryweather, George N., cor. 6th and Race Sts., Cincinnati, Ohio (30). **F H**
METCALF, ORLANDO, 424 Telephone Building, Pittsburgh, Pa. (35). **D**
Miller, Prof. Arthur M., State College, Lexington, Ky. (45). **E**
Miller, Prof. Dayton C., Case School of Applied Science, Cleveland. Ohio (44). **B**
MILLER, EDGAR G., 213 E. German St., Baltimore, Md. (29). **E F A**
Miller, Prof. Frank E., Westerville, Ohio (44). **A**
Miller, John A., 2500 Park Ave., Cairo, Ill. (22). **D**

Minns, Miss S., 14 Louisburg Square, Boston, Mass. (32).
Mitting, E. Kennard, 416 Huron St., Chicago, Ill. (40).
Mixer, Fred. K., 427 Delaware Ave., Buffalo, N. Y. (35). **E**
Mohler, John F., Dickinson Coll., Carlisle, Pa. (44). **B**
Molson, John H. R., Montreal, P. Q., Can. (31).
Moody, Lucius W., New Haven, Conn. (43). **H**
Moody, Mrs. Mary B., M.D., Fair Haven Heights, New Haven, Conn. (25). **E F**
Moore, Burton E., Lincoln, Neb. (41). **B**
Moore, Clarence B., 1321 Locust St., Philadelphia, Pa. (44). **H**
Moore, Geo. D., Ph.D., Polytechnic Inst., Worcester, Mass. (40).
Moore, Prof. Willis L., Chief of Weather Bureau, Dept. of Agric., Washington, D. C. (44). **B**
Morehead, J. Turner, Spray, N. C. (44). **C**
Morgan, Wm. F., Short Hills, N. J. (27).
Moseley, Edwin L., A.M., High School, Sandusky, Ohio (34).
Moss, Mrs. J. Osborne, Sandusky, Ohio (35). **F**
Moulton, Prof. Chas. W., Poughkeepsie, N. Y. (44). **C**
Mowry, Wm. A., 17 Riverside Square, Hyde Park, Mass. (29). **I**
Moxom, Philip Stafford, D.D., Springfield, Mass. (44). **H I**
Muckey, Floyd S., care W. Hallock, Columbia College, New York (44). **B**
Muir, John, Martinez, Cal. (22).
Mulford, Miss A. Isabel, Missouri Botanical Garden, St. Louis, Mo. (45). **G**
Mulliken, Samuel P., 46 High St., Newburyport, Mass. (43).
Munson, Prof. Welton M., Maine State College, Orono, Me. (41).
Murphy, Edward, M.D., New Harmony, Ind. (39). **C**
Myer, Mrs. Isaac, 21 E. 60th St., New York, N. Y. (44).
Myers, William S., S.B., F.C.S., Rutgers Coll., New Brunswick, N. J. (43). **C**
Myrick, Herbert, Springfield, Mass. (44).

Nardroff, Ernest R. von, 360ª Tompkins Ave., Brooklyn, N. Y. (44). **B**
Needham, James G., Cornell Univ., Ithaca, N. Y. (45). **F**
Neff, Peter, jr., Consulting Eng. and Supt., The Arctic Machine Mfg. Co., 10 West St., Cleveland, Ohio (34) **B**
Nelson, Julius, Ph.D., Rutgers College, New Brunswick, N. J. (43).
Nelson, Wm., Rooms 7 and 8, Paterson Nat'l Bank, Paterson, N. J. (42).
Nesmith, Henry E., jr., 28 South St., New York, N. Y. (30). **B F C**
Newson, John F., Ass't Prof. Geol., Univ. of Indiana, Bloomington, Ind. (44). **E**
Nichols, Austin P., 4 Highland Ave., Haverhill, Mass. (37).
Nichols, Miss Mary A., Cornell Univ., Ithaca, N. Y. (45).
Niven, William, 853 Broadway, New York, N. Y. (44).
Norton, Prof. Wm. H., Mt. Vernon, Iowa (39). **E**
Nourse, Prof. David O., Blacksburgh, Va. (43).
Noyes, Miss Mary C., Ph.D., Lake Erie Seminary, Painesville, Ohio (43).
Nunn, R. J., M.D., 119 York St., Savannah, Ga. (33). **B H**

O'Connor, Joseph, 146 Frank St., Rochester, N. Y. (41).
Olds, Prof. George D., Amherst, Mass. (38). **A**
O'Neill, Wm. Lane, Downing Building, New York, N. Y. (43).
Orleman, Miss Daisy M., M.D., Peekskill Military Acad., Peekskill, N. Y. (40). **F**
Osborne, Amos O., Waterville, Oneida Co., N. Y. (19). **E**
Osgood, Joseph B. F., Salem, Mass. (31).
Ostrander, Mrs. Sarah E., 910 Lafayette Ave., Brooklyn, N. Y. (43).
O'Sullivan, Rev. Denis T., S.J., 27 and 29 W. 16th St , New York, N. Y. (40). **B A**
Oviatt, David B., Georgia School of Technology, Atlanta, Ga. (40). **D**
Owen, Prof. D. A., Franklin, Ind. (34). **E**

PAGE, DR. DUDLEY L., 46 Merrimack St., Lowell, Mass. (33). **F**
PAGE, MRS. NELLIE K., 46 Merrimack St., Lowell, Mass. (33). **F**
Palmer, Dr. Edward, care F. V. Coville, Dep't of Agric., Washington, D. C. (22). **H**
Park, Dr. Roswell, Pres. Buff. Soc. Nat. Hist., 510 Delaware Ave., Buffalo, N. Y. (45). **H**
Parker, Harriet P., 2 Grace Court, Brooklyn, N. Y. (43).
Parker, Herschel C., 21 Fort Greene Place, Brooklyn, N. Y. (43).
Parks, C. Wellman, U. S. Patent Office, Washington, D. C. (42).
Parks, Prof. R. M., Bedford, Ind. (39). **C**
Parmelee, H. P., Charlevoix, Mich. (42). **H E**
PARSONS, JNO. E (36).
Patten, John, care The E. D. Onion Ice Co., Baltimore, Md. (43).
Patterson, Mrs. Flora Wambaugh, Ass't Pathologist, Dep't of Agric., Washington, D. C. (44). **G**
Patterson, Geo. W., jr., Ann Arbor, Mich. (44).
Patterson, Prof. James L , Union Coll., Schenectady, N. Y. (45).
Patton, Horace B., Golden, Col. (37). **E**
Paul, Caroline A., M.D., Vineland, Cumberland Co., N. J. (23).
Payne, Frank Fitz, Meteorological Office, Toronto, Ontario, Can. (38).
Peale, Albert C., M.D., U. S. Geol. Survey, Washington, D. C. (36). **E**
Peck, Mrs. Emma J., 44 Billings Park, Newton, Mass. (40).
Peck, Mrs. John H., 3 Irving Place, Troy, N. Y. (28).
Peck, W. A., C.E., 1051 Clarkson St., Denver, Col. (19). **E**
Peckham, Wheeler H., Drexel Building, Wall St., New York, N. Y. (36).
Pedrick, Miss Catherine F., Lawrence, Mass. (43).
Peirce, Cyrus N., D.D.S., 1415 Walnut St., Philadelphia, Pa. (31). **F**
Peirce, George James, Botanical Dep't, The Univ. of Indiana, Bloomington, Ind. (44). **G**
Pell, Alfred, Highland Falls, N. Y. (36).
PERKINS, ARTHUR, 14 State St., Hartford, Conn. (31). **B A**
Perkins, Frank K., Principal Grammar School No. 26, Gates Ave., near Ralph, Brooklyn, N. Y. (43).

Perry, Hon. Andrew J., 30 First Place, Brooklyn, N. Y. (43).
Petitdidier, O. L., Mt. Carmel, Ill. (39). **A B D**
Pettee, Rev. J. T., Meriden, Conn. (39).
Pettegrew, David Lyman, P. O. Box 1004, Worcester, Mass. (44). **A**
Pfister, Joseph Clement, 240 Sixth Ave. (Roseville), Newark, N. J. (43).
Phillips, Orville P., University, Los Angeles Co., Cal. (43).
Pickett, Dr. Thos. E., Maysville, Mason Co., Ky. (25). **H F**
Pickett, W. D., Wise, Big Horn Co., Wyo. (41). **D I**
Pierce, Josiah, jr., 922 Equitable Building, Baltimore, Md. (40). **E**
PIERREPONT, HENRY E., 216 Columbia Heights, Brooklyn, N. Y. (43).
Pike, J. W., Mahoning, Portage Co., Ohio (29). **E C F**
Pilling, J. W., 1301 Mass. Ave., Washington, D. C. (40).
Pillsbury, J. E., Lieut. U. S. N., 225 Commonwealth Ave., Boston, Mass. (33). **E B**
Pinney, Mrs. Augusta Robinson, 350 Central St., Springfield, Mass. (44). **F G**
Pitkin, Lucius, 138 Pearl St., New York, N. Y. (29).
Pitt, Prof. William H., 2 Arlington Place, Buffalo, N. Y. (25).
Place, Edwin, Terre Haute, Ind. (33). **B**
Pollard, Charles Louis, 1839 5th St., N. W., Washington, D. C. (44). **G**
Pomeroy, Charles Taylor, cor. Passaic & Reynolds Ave's, East Newark, N. J. (43).
Pope, Edward S., 235 Blackford St., Indianapolis, Ind (39).
Porteous, John, 176 Falmouth St., Boston, Mass. (22).
Porter, Miss Edna, 77 Bryant St., Buffalo, N. Y. (41). **F G**
Porter, Prof. James Madison, Lafayette Coll., Easton, Pa. (45). **D**
Post, Prof. Charles M., Alfred Centre, N. Y. (39). **B**
Potter, Mrs. Charles B., 111 Spring St., Rochester, N. Y. (41). **H**
Potter, Rev. Henry C., 804 Broadway, New York, N. Y. (29).
Potter, Henry Noel, 111 Spring St., Rochester, N. Y. (41). **B**
POTTER, O. B., 26 Lafayette Place, New York, N. Y. (36).
Prang, Louis, 45 Centre St., Roxbury, Mass. (29). **D**
Price, J. Sergeant, 709 Walnut St., Philadelphia, Pa. (33).
Proctor, Miss Edna Dean, Framingham, Mass. (44). **H**
Proctor, Miss Mary, 29 E. 46th St., New York, N. Y. (43). **A**
Prosser, Col. Wm. F., North Yakima, Yakima Co., Washington (26). **E I**
PRUYN, JOHN V. L., JR., Albany, N. Y. (29).
Pulsifer, Mrs. C. L. B., Newton Centre, Mass. (33).
Putnam, Chas. P., M.D., 63 Marlborough St., Boston, Mass. (28).
Putnam, Miss Elizabeth D., 2013 Brady St., Davenport, Iowa (45).
Putnam, Henry Cleveland, Eau Clair, Wis. (43).
Putnam, Joseph E., 123 State St., Rochester, N. Y. (45). **B**
Pynchon, William Harry Chichelé, Trinity Coll., Hartford, Conn. (44). **E**

Quick, Robert W., Georgia School of Technology, Atlanta, Ga. (43).

Rand, C. F., M.D., 1228 15th St. N. W., Washington, D. C. (27). **E H**
Randolph, Prof. L. S., Blacksburgh, Va. (33). **D**

Rane, Frank Wm., Exper. Station, Morgantown, W. Va. (42).
Reber, Prof. Louis E., State College, Centre Co., Pa. (35). **D**
Rèche, Miss Eugénie M., 31 Howell St., Rochester, N. Y. (41). **E H**
Redding, Prof. Allen C., 1000 No. Cory St., Findlay, Ohio (39). **C**
Redfield, William C., 107 Macon St., Brooklyn, N. Y. (44). **D**
Reed, Charles J., 3313 North 16th St., Philadelphia, Pa. (34). **C B**
Reed, John O., 34 E. Kingsley St., Ann Arbor, Mich. (44).
Reed, Taylor, Princeton, N. J. (38). **A**
Reichel, Rev. George V., Ph.D., Lock Box 85, Brockport, N. Y. (41) **F H**
Remington, Cyrus K., 11 E. Seneca St., Buffalo, N. Y. (35). **E**
Renninger, John S., M.D., Marshall, Minn. (31). **C F**
Reyburn, Robert, M.D., 2129 F St., N. W., Washington, D. C. (33). **F**
Reynolds, George, P. O. Box B, Salt Lake City, Utah (44). **H**
Rice, Arthur L., Pratt Institute, Brooklyn, N. Y., (43).
Rice, Edward L., A.B., Allegheny Coll., Meadville, Pa. (43).
Rice, Rev. William, Springfield, Mass. (44).
Rich, Jacob Monroe, 50 W. 38th St., New York, N. Y. (33). **B A**
Rich, Michael P., 50 W. 38th St., New York, N. Y. (40).
Ricketts, Col. R. Bruce, Wilkes Barre, Pa. (33). **E**
Rideout, Bates S., Norway, Me. (31). **E H**
Ries, Elias E., E. E., 1031 Temple Court, New York, N. Y. (33). **B I D**
Ries, Heinrich, Ph.B., Columbia College, New York, N. Y. (41). **E**
Riggs, Chauncey Wales, care of H. C. Warinner, 14 Madison St., Memphis, Tenn. (41). **H**
Riggs, Geo. W., Summit, N. J. (26). **C**
Ripley, William Z., Ph.D., Newton, Mass. (44). **H I**
Ritter, Homer P., U. S. C. and G. Survey, Washington, D. C. (40).
RIVERA, JOSÉ DE (29).
Roberts, Miss Jennie B., Round Hill, Conn. (43).
Robertson, James D., 411 and 412 Roe Building, St. Louis, Mo. (41). **E**
ROBERTSON, THOMAS D., Rockford, Ill. (10). **E H**
Robinson, Prof. Otis Hall, 273 Alexander St., Rochester, N. Y. (23). **B A**
Rochester, DeLancey, M.D., 469 Franklin St., Buffalo, N. Y. (35). **F**
Rockwood, Charles G., Drawer A, Newark, N. J. (36).
Roessler, Franz, 73 Pine St., New York, N. Y. (39).
Rolfe, Charles W., Urbana, Ill. (32).
Rolfs, P. H., Florida Agricultural College, Lake City, Fla. (41).
Rolker, Charles M., 30 Broad St., New York, N. Y. (43). **D**
ROOSEVELT, MRS. MARION T., 57 Fifth Avenue, New York, N. Y. (31). **H I**
Rosell, Claude A. O., 1131 9th St., N. W., Washington, D. C. (40).
Ross, Prof. Bennett Battle, A. & M. Coll., Auburn, Ala. (45). **C**
Ross, Denman Waldo, Ph.D., Cambridge, Mass. (29).
Roth, Filibert, U. S. Dep't of Agric., Washington, D. C. (39). **F**
Rothe, Wm. G., 226 Stuyvesant Ave., Brooklyn, N. Y. (43).
Rotzell, W. E., M.D., Narberth, Montgomery Co., Pa. (45). **F H**
Ruland, M. A., 292 Green Ave., Brooklyn, N. Y. (43).

Rupp, August, A. B., College of City of New York, New York, N. Y. (35).
Russell, A. H., Captain of Ordnance, U. S. A., Rock Island Arsenal, Rock Island, Ill. (38). **D**
Russell, Frank, Assistant in Anthropology, Harv. Univ., Peabody Museum, Cambridge, Mass. (45). **H**
Rust, Horatio N., Colton, San Bernardino Co., Cal. (26). **H**
Ryker, J. N., U. S. Weather Bureau, Lynchburg, Va. (41).

Sackett, Miss Eliza D., Cranford, N. J. (35). **F H**
Sage, John H., Portland, Conn. (23). **F**
Sander, Dr. Enno, St. Louis, Mo. (27). **C**
Saunders, Walter M., Olneyville, R. I. (43).
Sayre, Robert H., South Bethlehem, Pa. (28). **D**
SCHAFFER, CHAS., M.D., 1309 Arch St., Philadelphia, Pa. (29). **F E**
SCHAFFER, MRS. MARY TOWNSEND SHARPLESS, 1309 Arch St., Philadelphia, Pa. (38). **F E**
Scharar, Christian H., 2073 N. Main Ave., Scranton, Pa. (33). **A D E H**
SCHERMERHORN, F. AUG., 61 University Place, New York, N. Y. (36).
SCHERMERHORN, WM. C., 49 W. 23d St., New York, N. Y. (36).
Schieren, Hon. Charles A., Brooklyn, N. Y. (43). **I C**
Schimpf, Prof. Henry W., 365 Franklin Ave., Brooklyn, N. Y. (43).
Schmid, Dr. H. Ernest, White Plains, N. Y. (25).
Schneck, Jacob, M.D., Mount Carmel, Ill. (41). **E F H**
Schobinger, John J., 2101 Indiana Ave., Chicago, Ill. (34). **B**
Schöney, Dr. L., 68 East 104th St., New York, N. Y. (29). **F**
Schryver, Miss Annie A., Teachers College, New York, N. Y. (41).
Schuette, J. H., Green Bay, Wis. (34). **F E B**
Schultz, Carl H., 430-440 First Ave., New York, N. Y. (29).
Scott, Martin P., M.D., Maryland Agric., Coll., College Park, Md. (31).
Scoville, S. S., M.D., Lebanon, Ohio (30). **E F**
Searing, Anna H., M.D., Escondido, San Diego Co., Cal. (41). **G**
Sebert, William F., 353 Clinton St., Brooklyn, N. Y. (41). **A E**
Selby, Augustine Dawson, Ohio Agric. Exper. Station, Wooster, Ohio (44). **G**
Serrell, Lemuel W., 140 Nassau St., New York, N. Y. (36). **D**
Sharp, Dr. Clayton H., Ithaca, N. Y. (45).
Shaw, Cyrus W., Mountainville, Orange Co., N. Y. (43). **I**
SHEAFER, A. W., Pottsville, Pa. (28).
Shepardson, Prof. Geo. D., 1107 S. E. 7th St., Minneapolis, Minn. (45). **B D**
Shepherd, Elizabeth, 253 W. 128th St., New York, N. Y. (39).
Sherman, Orray Taft, 379 Harvard St., Cambridge, Mass. (39).
Shultz, Charles S., Hoboken, N. J. (31). **F**
Siebel, John E., Director Zymotechnic Inst., 1424 Montana St., Chicago, Ill. (39). **C B F E**
Siemon, Rudolph, 191 Calhoun St., Fort Wayne, Ind. (40). **A F**
SILVER, L. B., 172 Summit St., Cleveland, Ohio (37).

Simonds, Hon. Wm. E., Hartford, Conn. (44).
Sirrine, F. Atwood, Jamaica, Long Island, N. Y. (44).
Skiff, F. J. V., Director Field Columbian Museum, Chicago, Ill. (43).
Skilton, George S., 372 Decatur St., Brooklyn, N. Y. (43).
Slade, Elisha, Somerset, Bristol Co., Mass. (29). **F**
Slocum, Chas. E., M.D., Defiance, Ohio (34). **F**
Slosson, Prof. Edwin E., Univ. of Wyoming, Laramie, Wyo. (42).
Small, John Kunkel, Columbia College, New York, N. Y. (44).
Smillie, Thomas W., U. S. National Museum, Washington, D. C. (40). **F**
Smith, Arma A., West Camden, N. Y. (45).
Smith, Arthur Whitmore, Middletown, Conn. (44). **B**
Smith, Benj. G., 11 Fayerweather St., Cambridge, Mass. (29). **I**
Smith, Miss Cora A., Lansingburg, N. Y. (44). **F G**
Smith, De Cost, Skaneateles, N. Y. (38). **H**
Smith, Ernest Ellsworth, 262 Fifth Ave., New York, N. Y. (43).
Smith, E. Reuel, Skaneateles, N. Y. (38).
Smith, Prof. Harold B., Worcester Polytechnic Inst., Worcester, Mass. (43). **B**
Smith, Henry L., 149 Broadway, New York, N. Y. (26).
Smith, Prof. Herbert S. S., Princeton Univ., Princeton, N. J. (29). **D**
Smith, Herbert W., Corn Exchange, Minneapolis, Minn. (45). **E**
Smith, Miss J. Angelina, State Normal School, Framingham, Mass. (45). **E**
Smith, James Hervey, Baldwin Univ., Berea, Ohio (40).
Smith, Miss Jane, Peabody Museum, Cambridge, Mass. (29). **H**
Smith, Jos. R., Col. U. S. A., 2300 De Laney Place, Philadelphia, Pa. (43).
Smith, Lee Herbert, M.D., 224 Elmwood Ave., Buffalo, N. Y. (45). **H**
Smith, Mrs. Marshall E., 4608 Wayne St., Germantown, Philadelphia, Pa. (40). **H I**
Smith, Prof. Thomas A., Beloit, Wis. (33). **B A**
SMITH, USELMA C., 1515 Green St., Philadelphia, Pa. (33). **F**
Smyth, Prof. Jas. D., Burlington, Iowa (28). **I**
Snyder, Prof. Harry, St. Anthony Park, Minn. (44). **C**
Snyder, John F., M.D., Virginia, Cass Co., Ill. (42).
Soule, Wm., Ph.D., Alliance, Ohio (33). **B C E**
Southwick, E. B., Arsenal Building, Central Park, New York, N. Y. (36).
Souvielle, Mathieu, M.D., Box 355, Jacksonville, Fla. (36). **B E F**
Souvielle, Mrs. M., Box 355, Jacksonville, Fla. (24). **A B F**
Spencer, Arthur Coe, B.S., Sub station No. 2, Cleveland, Ohio (41). **E**
Speyers, Clarence L., Rutgers College, New Brunswick, N. J. (36). **C**
Spilsbury, E. Gybbon, 13 Burling Slip, New York, N. Y. (33). **E D**
Spinney, L. B., (42). **B**
Spofford, Paul N., P. O. Box 1667, New York, N. Y. (36).
SPRAGUE, C. H., Malden, Mass. (29).
Sprague, Frank J., 182 West End Ave., New York, N. Y. (29).
Spurr, Josiah E., A.B., 8 Gerring St., Gloucester, Mass. (43). **E**
Squibb, Charles F., A.B., 150 Columbia Heights, Brooklyn, N. Y. (43).
Squibb, Edward Hamilton, M.D., 148 Columbia Heights, Brooklyn, N. Y. (41). **F**

Stam, Colin F., Chestertown, Md. (33). **C F**
Stearns, John Brainerd, B.S., 44 So. Willard St., Burlington, Vt. (44). **C**
Stebbins, Miss Fannie A., 480 Union St., Springfield, Mass. (44). **G F**
Stebbins, George S., M.D., Springfield, Mass. (44). **H**
Steiger, George, Chem. Laboratory, U. S. Geol. Survey, Washington, D. C. (40). **C E B**
Stein, Dr. S. G., Muscatine, Iowa (43).
Stevens, Frank Lincoln, North High School, Columbus, Ohio (44). **G**
Stevens, Geo. T., M.D., 33 West 33d St., New York, N. Y. (28). **B F**
Stewart, Fred. Carlton, Jamaica, N. Y. (44). **G**
Stickney, Gardner P., 124 Grand Ave., Milwaukee, Wis. (44). **H**
Stillman, Prof. John M., Palo Alto, Cal. (41).
Stine, Prof. W. M., Director Elect. Dept., Armour Institute, Chicago, Ill. (37). **A C**
Stockwell, Chester Twitchell, 381 Main St., Springfield, Mass. (44). **H I**
Stoller, Prof. James H., Union College, Schenectady, N. Y. (36). **E F**
Stone, D. D., Lansing, N. Y. (39). **F**
Stone, Miss Ellen Appleton, 280 Waterman St., Providence, R. I. (42). **E F**
Stone, Lincoln R., M.D., Newton, Mass. (31).
Stoneman, Miss Bertha, Cornell Univ., Ithaca, N. Y. (45).
Stowell, John, 48 Main St., Charlestown, Mass. (21).
Stradling, Prof. George F., Hatboro, Montgomery Co., Pa. (41).
Streeruwitz, W. H. von, Austin, Texas (40).
Strong, Wendell M., 307 Welch Hall, New Haven, Conn. (44). **A B**
Stubbs, W. C., Audubon Park, New Orleans, La. (40).
Sullivan, J. A., 308 Main St., Malden, Mass. (27). **A**
Sullivan, J. C., M.D., Cairo, Ill. (40). **A**
Summers, Henry E., Champaign, Ill. (42). **F**
Sweet, Henry N., 89 State St., Boston, Mass. (40). **H D**
Sweetnam, Geo. Booker, 39 St. Vincent St., Toronto, Ontario, Can. (38).
Sylvester, Isaiah W., Passaic, N. J. (44). **C**

Taft, Elihu B., Burlington, Vt. (36). **H**
Talbott, Mrs. Laura Osborne, 927 P St., Washington, D. C. (36).
Talmage, Prof. James E., D.S.D., Ph.D., Curator Deseret Museum, Salt Lake City, Utah (41). **C F**
Taylor, C. F., M.D., 1520 Chestnut St., Philadelphia, Pa. (45).
Taylor, Edward Randolph, Cleveland, Ohio (39). **C**
Taylor, F. B., Box 2019, Fort Wayne, Ind. (39).
Taylor, Hudson K., 61 Fowler St., Cleveland, Ohio (42). **C**
Taylor, Prof. Jas. M., Hamilton, Madison Co., N. Y. (33). **A D**
Taylor, Robert S., Box 2019, Fort Wayne, Ind. (39).
Taylor, William Alton, 1516 Caroline St., N. W., Washington, D. C. (40).
Ternan, James C., P. O. Drawer 1033, Rochester, N. Y. (43).
Thaw, Mrs. Mary Copley, Pittsburgh, Pa. (41). **H**
Theilmann, Emil, 1020 E. 10th St., Kansas City, Mo. (41).
Thompson, Alton Howard, 721 Kansas Ave., Topeka, Kan. (33). **H**

Thompson, Daniel G., 120 Broadway, New York, N. Y. (29).
Thompson, Mrs. Frank, 233 South 4th St., Philadelphia, Pa. (33).
THOMPSON, FRED'K F., 283 Madison Ave., New York, N. Y. (36).
Thompson, J. L., M.D., Indianapolis, Ind. (39). **F**
Thornburg, Charles L., Prof. Math. and Astron., Lehigh Univ., South Bethlehem, Pa. (44). **A**
Tiffany, Asa S., 1221 Rock Island St., Davenport, Iowa (27). **E H**
Tight, Prof. William George, Granville, Ohio (39). **F**
Tilden, Dr. J. N., Peekskill, N. Y. (43).
Tindall, Willoughby C., Associate Prof. of Math., Univ. of Missouri, Columbia, Mo. (40).
Todd, Albert M., Nottawa, Mich. (37). **C**
Towle, Wm. Mason, State College, Center Co., Pa. (44). **D**
Townsend, Prof. Charles O., Macon, Ga. (41). **F**
Townsend, Clinton P., Donaldsonville, La. (40). **C**
Townsend, Franklin, 4 Elk St., Albany, N. Y. (4).
Treat, Erastus B., Publisher and Bookseller, 5 Cooper Union, cor. 4th Ave. and 8th St., New York, N. Y. (29). **F I**
Trowbridge, Luther H., East Grand Circus Park, Detroit, Mich. (29).
Trowbridge, Mrs. M. E. D., East Grand Circus Park, Detroit, Mich. (21). **I G**
Tudor, Joseph H., State College, Pa. (39). **A**
Turner, J. Spencer, 109 Duane St., New York, N. Y. (43). **B**

Vail, Prof. Hugh D., Santa Barbara, Cal. (18).
Valentine, Benj. B., Richmond, Va. (33). **H**
Valentine, Edw. P., Richmond, Va. (33). **H**
VAN BEUREN, FREDERICK T., 21 W. 14th St., New York, N. Y. (36).
Van Brunt, Cornelius, 319 E. 57th St., New York, N. Y. (28).
Van Slyke, James M., Madison, Wis. (42). **F**
Varney, A. L., Major of Ordnance, U. S. A., Indianapolis Arsenal, Indianapolis, Ind. (44). **H**
VAUX, GEO., JR., 404 Girard Building, Philadelphia, Pa. (33). **E A**
Vermyné, J. J. B., M.D., 2 Orchard St., New Bedford, Mass. (29). **F**
Villard, Fanny G., Dobbs Ferry, N. Y. (36).
Vinal, W. Irving, 1106 East Capitol St., Washington, D. C. (40). **E**
Volk, Ernest, Trenton, N. J. (42). **H**
Voorhees, Chas. H., M.D., P. O. Lock Box 120, New Brunswick, N. J. (29). **F H**
Vredenburgh, Edw. H., 122 So. Fitzhugh St., Rochester, N. Y. (29).

Wagner, Frank C., care Wm. Wagner, Ann Arbor, Mich. (34). **D**
Wales, Salem H., 25 E. 55th St., New York, N. Y. (36).
Walker, Byron Edmund, Toronto, Ontario, Can. (38). **E**
Walker, George C., Room 519, Rookery Building, Chicago, Ill. (17).
Walker, James, Seth Thomas Clock Co., 49 Maiden Lane, New York, N. Y. (43).

Walworth, Rev. Clarence A., 41 Chapel St., Albany, N. Y. (28). **E**
Wappenhaus, C. F. R., U. S. Weather Bureau, Indianapolis, Ind. (39). **B**
Ward, Frank A., 16–26 College Ave., Rochester, N. Y. (40).
Ward, J. Langdon, 120 Broadway, New York, N. Y. (29). **I**
Wardwell, George J., Rutland, Vt. (20). **D E**
Ware, Wm. R., Columbia Coll., New York, N. Y. (36).
Waring, John, Ovid, N. Y. (33). **D B**
Warren, Eugene C., 611 W. Main St., Louisville, Ky. (37).
Warren, Mrs. Susan E., 67 Mt. Vernon St., Boston, Mass. (29).
Warrington, James N., 127 Park Ave., Chicago, Ill. (34). **D A B**
Washburn, Prof. F. L., State Univ., Eugene, Oregon (44). **F**
Washington, Dr. Henry S., Locust, N. J. (44). **E**
WATERS, GEO. F., 6 Somerset St., Boston, Mass. (29). **B F H E D**
Watkins, L. D., Manchester, Mich. (34). **F**
Watson, Miss C. A., Salem, Mass. (31). **D**
Watson, Elizabeth S., Weymouth, Mass. (42). **E**
Watson, Thomas A., Weymouth, Mass. (42). **E**
Watson, Thomas L., Agric. Exper. Station, Agric. and Mechan. College, Blacksburgh, Va. (42).
Watters, William, M.D., 26 So. Common St., Lynn, Mass. (40). **E G**
Watts, A. J., M.D., 1123 Bedford Ave., Brooklyn, N. Y. (43).
Waugh, D. W., M.D., 388 Clinton St., Brooklyn, N. Y. (43).
Weaver, Gerrit E. Hambleton, A.M., 203 De Kalb Square, West Philadelphia, Pa. (38). **G I**
Webster, Mrs. N. B., Vineland, N. J. (43).
Weed, H. E., Agricultural College, Miss. (40). **F**
Weed, J. N., 71 Water St., Newburgh, N. Y. (37). **E I**
Weeden, Hon. Joseph E., Randolph, Cattaraugus Co., N. Y. (31).
Weeks, Fred Boughton, U. S. Geol. Survey, Washington, D. C. (44). **E**
Weeks, Joseph D., Editor Amer. Manufacturer, Pittsburgh, Pa. (35). **D**
Weems, J. B., Ph.D., Iowa Agric. College, Ames, Iowa (44). **C**
Weinzirl, John, Univ. of Wisconsin, Madison, Wis. (45). **G**
Wells, Mrs. C. F., 27 E. 21st St., New York, N. Y. (31). **H F I D B**
Wells, Samuel, 31 Pemberton Square, Boston, Mass. (24). **H**
Wells, William H., jr., 274 Ashland Ave., Chicago, Ill. (39). **E**
Wernicke, Prof. Paul, 107 E. Maxwell St., Lexington, Ky. (44). **A B**
Werum, Jno. H., Toledo, Ohio (40).
Wetzler, Jos., 203 Broadway, New York, N. Y. (36).
Wheeler, Herbert A., 2700 Pine St., St. Louis, Mo. (33). **E I**
Wheeler, T. B., M.D., 123 Metcalfe St., Montreal, P. Q., Can. (11).
Wheeler, William, C.E., Concord, Mass. (41).
Whetstone, John L., Summit Ave., Mt. Auburn, Cincinnati, Ohio (30). **D**
White, LeRoy S., Box 924, Waterbury, Conn. (23).
White, Thaddeus R., 257 W. 45th St., New York, N. Y. (42). **A**
Whitehead, John M., Att'y at Law, Janesville, Rock Co., Wis. (41). **I**
Whitfield, Thomas, Ph.D., 240 Wabash Ave., Chicago, Ill. (41). **C**
Whiting, Mrs. Francis, 914 W. Lafayette St., Norristown, Pa. (40).

Whiting, S. B., 11 Ware St., Cambridge, Mass. (33). **D**
Whitman, Prof. Charles O., Chicago Univ., Chicago, Ill. (43). **F**
Whitney, E. R., 20 North St., Binghamton, N. Y. (41).
Wiegand, Karl McKay, Ithaca, N. Y. (45). **G**
Wilbour, Mrs. Charlotte B., Little Compton, R. I. (28).
Wilbur, Miss F. Isabel, 1719 15th St., N. W., Washington, D. C. (42). **E H**
Wilcox, Miss Emily T., Meriden, Conn. (33). **B A**
Wilder, Geo. Walker, Univ. of Wisconsin, Madison, Wis. (45). **B**
Wilkinson, J. Henderson, 320 E. Capitol St., Washington, D. C. (35). **E**
Willard, Prof. Joseph A., State College, Centre Co., Pa. (44). **A**
Willetts, Joseph C., Skaneateles, N. Y. (29). **E F H**
Williams, Henry Smith, M.D., 165 West 82nd St., New York, N. Y. (34). **F**
Willitts, George E., 709 S. Grand St., Lansing, Mich. (39). **F**
Willoughby, Charles C., Peabody Museum, Cambridge, Mass. (45). **H**
WILMARTH, MRS. HENRY D., 51 Eliot St., Jamaica Plain, Mass. (40).
Wilmot, Thos. J., Commercial Cable Co., Waterville, County Kerry, Ireland (27). **B**
Wilson, Prof. Andrew G., Lenox Coll., Hopkinton, Iowa (43). **E**
Wilson, Fred., 337 Fourth Ave., New York, N. Y. (43).
Wilson, G. Reed, Townsend Block, Main cor. Swan St., Buffalo, N. Y. (45). **H**
Wingate, Miss Hannah S., 103 W. 132nd St., New York, N. Y. (31). **E I**
Wolcott, Mrs. Henrietta L. T., Dedham, Mass. (29).
Woll, Fritz Wilhelm, Madison, Wis. (42). **C**
Wood, Rev. Charles, D.D., West Walnut Lane, Germantown, Pa. (43).
Wood, Mrs. Cynthia A., 171 W. 47th St., New York, N. Y. (43).
Wood, Thomas Bond, LL.D., care U. S. Legation, Lima, Peru (43).
WOOD, WALTER, 400 Chestnut St., Philadelphia, Pa. (33). **F I**
Woodhull, John Francis, Teachers' College, Morningside Heights, New York, N. Y. (43).
Woodrow, Miss Marion W., Winthrop Normal Coll., Rock Hill, S.C. (45). **E C**
Woods, Albert F., U. S. Dept. Agric., Washington, D. C. (43).
Woodworth, William McMichael, Ph.D., 149 Brattle St., Cambridge, Mass. (44). **F**
Wrenshall, John C., Baltimore, Md. (40). **H**
Wright, Jonathan, M.D., 73 Remsen St., Brooklyn, N. Y. (43).
Wright, John S., care Eli Lilly & Co., Indianapolis, Ind. (42). **G**
Wright, Rufus, 338–339 Lake St., Chicago, Ill. (37). **B**
Wright, S. G., La Fayette, Ind. (42). **G**
Wunderlich, Frederick W., M.D., 165 Remsen St., Brooklyn, N. Y. (45).
Würtele, Miss Minnie, Acton Vale, P. Q., Can. (32). **H**

Youmans, Mrs. Celia G., Mount Vernon, N. Y. (36).
Youmans, Vincent J., Mt. Vernon, N. Y. (43).
Yowell, Everett I., Station "C," Cincinnati, Ohio (41). **A**

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Zeng, Miss Nellie E. de, Clyde, Wayne Co., N. Y. (41). **B H**
Ziegler, William, 45–49 Cedar St., New York, N. Y. (43).

[994 PATRONS, CORRESPONDING MEMBERS AND MEMBERS.]

NOTE.—The omission of an address in the foregoing list indicates that letters mailed to that last printed were returned as uncalled for. Information of the present address of the members so indicated is requested by the PERMANENT SECRETARY.

SURVIVING FOUNDERS.

[At the Brooklyn Meeting, 1894, a resolution was unanimously adopted by which all surviving founders of the Association who have maintained an interest in science were made Honorary Life Members of the Association in recognition of their pioneer work in American Science.]

BOYÉ, Martin H., Coopersburg, Pa.
DIXWELL, EPES S., Cambridge, Mass.
GREEN, TRAILL, Easton, Pa.
HALL, JAMES, Albany, N. Y.
HUBBARD, OLIVER PAYSON, New York, N. Y.
WEST, CHARLES E., Brooklyn, N. Y.

(56)

HONORARY FELLOWS.[1]

ROGERS, PROF. WILLIAM B., Boston, Mass. (1). 1881. (Born Dec. 7, 1804. Died May 30, 1882.) **B E**

CHEVREUL, MICHEL EUGÈNE, Paris, France (35). 1886. (Born Aug. 31, 1786. Died April 9, 1889.). **C**

GENTH, DR. F. A., 3937 Locust St., Philadelphia, Pa. (24). 1888. (Born May 17, 1820. Died Feb. 2, 1892.) **C E**

HALL, PROF. JAMES, Albany, N. Y. (1). 1890. **E F**

GOULD, DR. BENJAMIN APTHORP, Cambridge, Mass. (2). 1895. Born Sept. 27, 1824. Died Nov. 26, 1896. **A B**

LEUCKART, PROF. RUDOLF, Leipsic, Saxony, Germany. (44). 1895. **F**

GIBBS, PROF. WOLCOTT, Newport, R. I. (45). 1896. **C B**

FELLOWS.[2]

Abbe, Professor Cleveland, Meteorologist, Weather Bureau, Dept. of Agric., Washington, D. C. (16). 1874. **B A**

Abbe, Dr. Robert, 11 W. 50th St., New York, N. Y. (36). 1892.

Abert, S. Thayer, 1108 G St., N. W., Washington, D. C. (30). 1891. **A B D E I**

Adriance, John S., 231 Broadway, New York, N.Y. (39). 1895. **C**

Alden, Prof. Geo. I., Worcester, Mass. (33). 1885. **D**

Allen, Dr. T. F., 10 E. 36th St., New York, N. Y. (35). 1887. **G**

Alvord, Major Henry E., Lewinsville, Fairfax Co., Va. (29). 1882. **I**

Alwood, Prof. Wm. B., Agricultural and Mechanical College and Experiment Station, Blacksburg, Va. (39). 1891. **F**

Andrews, Prof. Launcelot W., Iowa City, Iowa (39). 1891. **C**

Anthony, Prof. Wm. A., 5 Beekman St., Temple Court, New York, N. Y. (28). 1880. **B**

Arthur, J. C., Lafayette, Ind. (21). 1883. **G**

Ashmead, Wm. H., 1833 M St., N. W., Washington, D. C. (40). 1892. **F**

Atkinson, Edward, 31 Milk St., Boston, Mass. (29). 1881. **I D**

Atkinson, George F., Cornell Univ., Ithaca, N. Y. (39). 1892. **G**

Atwater, Prof. W. O., Wesleyan Univ., Middletown, Conn. (29). 1882. **C**

Atwell, Charles B., 1938 Sherman Ave., Evanston, Ill. (36). 1890. **F**

Auchincloss, Wm. S., Bryn Mawr, Pa. (29). 1886. **D A**

Austen, Prof. Peter T., 99 Livingston St., Brooklyn, N. Y. (44). 1896. **C**

Avery, Elroy M., Ph.D., LL.D., 657 Woodland Hills Ave., Cleveland, Ohio (37). 1889. **B**

Ayres, Prof. Brown, Tulane Univ., New Orleans, La. (31). 1885. **B**

[1] See ARTICLE VI of the Constitution. [2] See ARTICLE IV of the Constitution.

*** The number in parenthesis indicates the meeting at which the member joined the Association; the date following is the year when made a Fellow; the black letters at end of line are those of the sections to which the Fellow belongs.

When the name is given in small capitals, it designates that the Fellow is also a Life Member.

Babcock, Prof. S. Moulton, Madison, Wis. (33). 1885. **C**

Bailey, E. H. S., Lawrence, Douglas Co., Kan. (25). 1889. **C E**

Bailey, Prof. Liberty H., Cornell Univ., Ithaca, N. Y. (34). 1887. **G**

Baker, Frank, M.D., 1315 Corcoran St., Washington, D. C. (31). 1886. **F H**

Baker, Marcus, U. S. Geological Survey, Washington, D. C. (30). 1882. **A**

Ballard, Harlan H., 50 South St., Pittsfield, Mass. (31). 1891. **E F**

BARKER, PROF. G. F., 3909 Locust St., Philadelphia, Pa. (13). 1875. **B C**

Barnard, Edward E., care Yerkes Observatory, Lake Geneva, Williams Bay P. O., Wis. (26). 1883. **A**

Barnes, Chas. Reid, Prof. Botany University of Wisconsin, 616 Lake St., Madison, Wis. (33). 1885. **G**

Barnes, David Leonard, A. M., Suite 1750, The Monadnock, Chicago, Ill. (43). 1896. **D**

Barnum, Miss Charlotte C., Ph.D., 144 Humphrey St., New Haven, Conn. (36). 1896. **A**

Bartlett, Prof. Edwin J., Dartmouth College, Hanover, N. H. (28). 1883. **C**

Bartlett, John R., Commander U. S. N., Lonsdale, R. I. (30). 1882. **E B**

Bartley, Elias H., M.D., 21 Lafayette Ave., Brooklyn, N. Y. (33). 1894. **C**

Barus, Carl, Ph.D., 2808 N St., N. W., Washington, D. C. (33). 1887. **B**

Baskerville, Charles, Univ. of North Carolina, Chapel Hill, N. C. (41). 1894. **C**

Bassett, Homer F., Waterbury, Conn. (23). 1874. **F**

Bates, Henry H., Ph.D., U. S. Patent Office, Washington, D. C. (33). 1887. **B A C D**

Battle, Herbert B., Ph.D., Director N. C. Agric. Exper. Station, Raleigh, N. C. (33). 1889. **C**

Bauer, Louis A., Ph.D., University of Chicago, Chicago, Ill. (40). 1892. **A**

Bausch, Edw., P. O. Drawer 1033, Rochester, N. Y. (26). 1883. **A B C F**

Beal, Prof. Wm. James, Agricultural College, Ingham Co., Mich. (17). 1880. **G**

Beardsley, Prof. Arthur, C.E., Ph.D., Swarthmore College, Swarthmore, Del. Co., Pa. (33). 1885. **D**

Beauchamp, Rev. Wm. M., Baldwinsville, N. Y. (34). 1886. **H**

Becker, Dr. Geo. F., U. S. Geol. Survey, Washington, D. C. (36). 1890. **E**

Bedell, Frederick, Ph.D., Cornell Univ., Ithaca, N. Y. (41). 1894. **B A**

Bell, Alex. Melville, 1525 35th St., Washington, D. C. (31). 1885. **H**

Bell, Robert, M.D., Ass't Director Geological Survey, Ottawa, Ontario, Can. (38). 1889. **E F**

Beman, Wooster W., 19 So. 5th St., Ann Arbor, Mich. (34). 1886. **A**

BENJAMIN, MARCUS, Smithsonian Institution, Washington, D. C. (27). 1887. **C**

Benjamin, Rev. Raphael, M.A., 28 E. 76 St., New York, N. Y. (34). 1887. **E F G H**

Bessey, Prof. Charles E., Univ. of Nebraska, Lincoln, Neb. (21). 1880. **G**

Bethune, Rev. C. J. S., Trinity College School, Pt. Hope, Ont., Can. (18). 1875. **F**

Beyer, Dr. Henry G., U. S. N., U. S. Naval Acad., Annapolis, Md. (31). 1884. **F**

Bickmore, Prof. Albert S., American Museum of Natural History, 8th Ave. and 77th St., Central Park, New York, N. Y. (17). 1880. **H**

Bigelow, Prof. Frank H., U. S. Weather Bureau, Washington, D. C. (36). 1888. **A**

Billings, John S., Surgeon U. S. A., Surg. General's Office, Washington, D. C. (32). 1883. **F H**

BIXBY, W. H., Major, Corps of Engineers, U. S. A., L. H. Eng. Office, Room 20, 4th Floor, P. O. Building, Philadelphia, Pa. (34). 1892. **D**

Blackham, George E., M.D., Dunkirk, N. Y. (25). 1883. **F**

Blair, Andrew A., 406 Locust St., Philadelphia, Pa. (44). 1896. **C**

Blake, Clarence J., M.D., 226 Marlborough St., Boston, Mass. (24). 1877. **B F**

Blake, Francis, Auburndale, Mass. (23). 1874. **B A**

Boardman, Mrs. William D., care of Baring Brothers & Co., London, England (28). 1885. **E H**

Boas, Dr. Franz, Amer. Museum Natural History, Central Park, New York, N. Y. (36). 1888. **H I**

Boerner, Chas. G., Vevay, Switzerland Co., Ind. (29). 1886. **A B E**

Bolley, Henry L., North Dakota Exper. Station, Fargo, North Dakota (39). 1892. **G**

BOLTON, DR. H. CARRINGTON, Cosmos Club, Washington, D. C. (17). 1875. **C**

Bond, Geo. M., care of The Pratt & Whitney Co., Hartford, Conn. (33). 1885. **D**

Booth, Miss Mary A., 32 Byers St., Springfield, Mass. 1894. **F I G**

Bowditch, Prof. H. P., Jamaica Plain, Mass. (28). 1880. **F B H**

Bowser, Prof. E. A., Rutgers College, New Brunswick, N. J. (28). 1881.

BOYÉ, MARTIN H., M.D., Coopersburg, Lehigh Co., Pa. (1). 1896. **C**

Boynton, Prof. C. Smith, 69 No. Prospect St., Burlington, Vt. (44). 1896. **C**

Brackett, Richard N., Associate Prof. of Chemistry, Clemson College, S. C. (37). **C E**

Bradford, Royal B., Commander U. S. N., care Navy Dept., Washington, D. C. (31). 1891. **B D**

Branner, Prof. John C., Stanford University, Cal. (34). 1886. **E F**

Brashear, Jno. A., Allegheny, Pa. (33). 1885. **A B D**

Brewer, Prof. Wm. H., New Haven, Conn. (20). 1875. **E F I**

Brinton, D. G., M.D., Media, Pa. (33). 1885. **H**

Bristol, Wm. H., Stevens Institute, Hoboken, N. J. (36). 1894. **A B D**

Britton, N. L., Ph.D., Director-in-chief N. Y. Botanical Garden, 41 E. 49th St., New York, N. Y. (29). 1882. **G E**

Broadhead, Prof. Garland Carr, University, Columbia, Mo. (27). 1879. **E**

Brooks, Wm. R., Box 714, Geneva, N. Y. (35). 1886. **A B D G**

Brown, Robert, care of Yale College Observatory, New Haven, Conn. (11). 1874.

Brown, Mrs. Robert, New Haven, Conn. (17). 1874.

Brühl, Gustav, cor. John and Hopkins Sts., Cincinnati, Ohio (28). 1886. **H**

Brush, Charles F., Brush Electric Light Co., Cleveland, Ohio (35). 1886. **B**

BRUSH, PROF. GEORGE J., Yale College, New Haven, Conn. (4). 1874. **C E**

Buckhout, W. A., State College, Centre Co., Pa. (20). 1881. **F**

Burgess, Dr. Thomas J. W., Med. Sup't, Protestant Hospital for the Insane, Montreal, P. Q., Can. (38). 1889. **G**

Burr, Prof. William H., School of Mines, 41 East 49th St., New York, N. Y. (31). 1883.

Butler, A. W., Brookville, Franklin Co., Ind. (30). 1885. **F H**

Caldwell, Prof. Geo. C., Cornell University, Ithaca, N. Y. (23). 1875. **C**

Calvin, Prof. Samuel, State Univ. of Iowa, Iowa City, Iowa (37). 1889. **E F**

Campbell, Prof. Douglas H., Menlo Park, Cal. (34). 1888. **G**

Campbell, Prof. Edw. D., Ann Arbor, Mich. (44) 1896. **C**

Canby, William M., 1101 Delaware Avenue, Wilmington, Del. (17). 1878. **G**

Carhart, Prof. Henry S., University of Michigan, Ann Arbor, Mich. (29). 1881. **B**

Carleton, M. A., Dep't Agric., Div. of Vegetable Pathology, Washington, D. C. (42) 1894. **G**

Carpenter, Louis G., Agric. Coll., Fort Collins, Col. (32). 1889. **A B**

Carpenter, Capt. W. L., U. S. A., care Adjutant General, Washington, D. C. (24). 1877. **F E**

Carter, James Madison G., M.D., Waukegan, Ill. (39). 1895. **F**

Carus, Paul, Ph.D., La Salle, Ill. (40). 1895. **H**

Casey, Thomas L., 1419 K St., N. W., Washington, D. C. (38). 1892. **F**

Catlin, Charles A., 133 Hope St., Providence, R. I. (33). 1895. **C**

Cattell, Prof. James McKeen, Columbia Univ., New York, N. Y. (44). 1896. **B F H I**

Chalmot, G. de, Spray, N. C. (44). 1896. **C**

Chamberlain, Alexander F., Clark Univ., Worcester, Mass. (38). 1890. **H**

Chamberlin, T. C., 5041 Madison Ave., Chicago, Ill. (21). 1877. **E B F H**

Chandler, Prof. C. F., School of Mines, Columbia Coll., East 49th St., cor. 4th Ave., New York, N. Y. (19). 1875. **C**

Chandler, Prof. Charles Henry, Ripon, Wis. (28). 1883. **A B**

Chandler, Seth C., 16 Craigie St., Cambridge, Mass. (29). 1882. **A**

Chandler, Prof. W. H., South Bethlehem, Pa. (19). 1894. **C**

Chanute, O., 413 E. Huron St., Chicago, Ill. (17). 1877. **D I**

Charbonnier, Prof. L. H., University of Georgia, Athens, Ga. (26). 1894. **A B D**

Cheney, Lellen Sterling, 1081 W. Johnson St., Madison, Wis. (42). 1894. **G**

(60)

Chester, Prof. Albert H., Rutgers College, New Brunswick, N. J. (29). 1882. **C F**

Christie, James, Pencoyd, Pa. (33). 1894. **D**

Christy, Prof. Samuel B., Box 41, Berkeley, Cal. (35). 1894. **D**

Chute, Horatio N., Ann Arbor, Mich. (34). 1889. **B C A**

Clark, Alvan G., Cambridgeport, Mass. (28). 1880. **A B**

Clark, Prof. John E., 445 Orange St., New Haven, Conn. (17). 1875. **A**

Clark, Wm. Bullock, Ph.D., Johns Hopkins Univ., Baltimore, Md. (37). 1891. **E**

Clarke, Prof. F. W., U. S. Geological Survey, Washington, D. C. (18). 1874. **C**

Clarke, Robert, Cincinnati, Ohio. (30). 1895. **H**

Claypole, Prof. Edw. W., 603 Buchtel Ave., Akron, Ohio (30). 1882. **E F**

Cloud, John W., 974 Rookery, Chicago, Ill. (28). 1886. **A B D**

Coffin, Prof. Selden J., Lafayette College, Easton, Pa. (22). 1874. **A I**

Cogswell, W. B., Syracuse, N. Y. (33). 1891. **D**

COLBURN, RICHARD T., Elizabeth, N. J. (31). 1894. **I F H**

Cole, Prof. Alfred D., Denison Univ., Granville, Ohio (39). 1891. **B C**

Collin, Prof. Alonzo, Cornell College, Mount Vernon, Iowa (21). 1891. **B C**

Collingwood, Francis, Elizabeth, N. J. (36). 1888. **D**

Colvin, Verplanck, Supt. N. Y. State Adirondack Survey, Albany, N. Y. (28). 1880. **E**

Comstock, Prof. Geo. C., Washburn Observ., Univ. of Wisconsin, Madison, Wis. (34). 1887. **A**

Comstock, Milton L., 641 Academy St., Galesburg, Ill. (21). 1874. **A**

Comstock, Prof. Theo. B., President Univ. of Arizona, Tucson, Arizona (24). 1877. **D E B**

Conant, Prof. L. L., Polytechnic Inst., Worcester, Mass. (39). 1892. **A**

Cook, Prof. A. J., Pomona College, Claremont, Cal. (24). 1880. **F**

Cook, Prof. Orator F., Huntington, N. Y. (40). 1892. **G**

Cooley, Prof. Le Roy C., Vassar College, Poughkeepsie, N. Y. (19). 1880. **B C**

Cooley, Prof. Mortimer E., Univ. of Michigan, Ann Arbor, Mich. (33). 1885. **D**

Cope, Prof. Edward D., 2102 Pine St., Philadelphia, Pa. (17). 1875. **F E**

Corthell, Elmer L., 71 Broadway, New York, N. Y. (34). 1886. **D I E**

Coulter, Prof. John M., Univ. of Chicago, Chicago, Ill. (32). 1884. **G**

Coville, Frederick V., Dept. of Agric., Washington, D. C. (35). 1890. **G**

Cox, Hon. Jacob D., Gilman Ave., Mt. Auburn, Cincinnati, Ohio (30). 1881. **F**

Cragin, Francis W., Colorado College, Colorado Springs, Col. (29). 1890. **F E H**

Crampton, Chas. A., M.D., Office of Internal Revenue, Treasury Department, Washington, D. C. (36). 1887. **C**

Crandall, Prof. Charles S., Fort Collins, Col. (40). 1894.

Crawford, Prof. Morris B., Middletown, Conn. (30). 1889. **B**

Crockett, Charles W., Rensselaer Polytechnic Inst., Troy, N. Y. (39). 1894. **A D**

Cross, Prof. Chas. R., Mass. Institute Technology, Boston, Mass. (29). 1880. **B**

Culin, Stewart, Univ. of Pa., Philadelphia, Pa. (33). 1890. **H**

Cummings, John, Cummingsville, Woburn, Mass. (18). 1890. **F**

Cushing, Frank H., Bureau of Ethnology, Washington, D. C. (40). 1893. **H**

Cushing, Henry Platt, Adelbert College, Cleveland, Ohio (33). 1888. **E**

Dall, William H., Smithsonian Institution, Washington, D. C. (18). 1874. **H F**

Dana, Edward Salisbury, New Haven, Conn. (23). 1875. **B E**

Dana, Gen. James J., U. S. A., 1412 21st St., N. W., Washington, D. C. (40). 1896.

Daniel, John, Vanderbilt Univ., Nashville, Tenn. (38). 1894. **B**

Darton, Nelson H., U. S. Geol. Survey, Washington, D. C. (37). 1893.

Davis, C. H., Commander U. S. N., Navy Dept., Washington, D. C. (40). 1896.

Davis, Prof. Wm. Morris, Cambridge, Mass. (33). 1885. **E B**

Dawson, Geo. M., S.S.C., F.G.S., Geol. Survey, Ottawa, Ontario, Can. (38). 1895. **E**

Dawson, Sir William, Principal McGill College, Montreal, Can. (10). 1875. **E**

Day, David F., Buffalo, N. Y. (35). 1887. **G**

Day, Fisk H., M.D., 309 Sycamore St., Lansing, Mich. (20). 1874. **E H F**

Dean, George W., P. O. Box 92, Fall River, Mass. (15). 1874. **A**

Dennis, Louis Monroe, Cornell Univ., Ithaca, N. Y. (43). 1895. **C**

Denton, Prof. James E., Stevens Institute, Hoboken, N. J. (36). 1888. **D B A**

Derby, Orville A., San Paulo, Brazil, S. A. (39). 1890.

Dexter, Julius, Cincinnati, Ohio (30).

Dimmock, George, 679 State St., Springfield, Mass. (22). 1874. **F**

DIXWELL, EPES S., Cambridge, Mass. (1). 1896. **H F**

Dolbear, Prof. A. Emerson, Tufts College, Mass. (20). 1880. **B**

Doolittle, Prof. C. L., Univ. of Penn., Philadelphia, Pa. (25). 1885. **A**

Dorsey, George A., Ph. D., Ass't in Anthropology, Field Columbian Museum, Chicago, Ill. (39). 1892. **H**

Douglass, Andrew E., Amer. Mus. of Nat. Hist., Central Park, New York, N. Y. (31). 1885. **H**

DRAPER, DAN'L, Ph.D., Director N. Y. Meteorological Observatory, Central Park, 64th St., Fifth Avenue, New York, N. Y. (29). 1881. **B D F A**

Drown, Prof. Thos. M., Lehigh Univ., South Bethlehem, Pa. (29). 1881. **C**

DU BOIS, PROF. AUG. J., New Haven, Conn. (30). 1882. **A B D**

Du Bois, Patterson, Ass't Editor S.S.T., 1031 Walnut St., Philadelphia, Pa. (33). 1887. **H C I**

Dudley, Charles B., Drawer 334, Altoona, Pa. (23). 1882. **C B D**

DUDLEY, WM. L., Prof. of Chemistry, Vanderbilt Univ., Nashville, Tenn. (28). 1881. **C**

Dudley, Prof. Wm. R., Leland Stanford jr. Univ., Palo Alto, Cal. (29). 1883. **G**
Dumble, E. T., Austin, Texas (37). 1891. **E**
Dunham, Edw. K., 338 East 26th St., New York, N. Y. (30). 1890.
Dunnington, Prof. F. P., University Station, Charlottesville, Va. (26). 1880. **C**
Du Pont, Francis G., Wilmington, Del. (33). 1896. **A B D**
Dwight, Prof. William B., Vassar College, Poughkeepsie, N. Y. (30). 1882. **E F**

Earle, F. S., Prof. of Biology, Alabama Polytechnic Inst., Auburn, Ala. (39). 1896. **G**
Eastman, Charles Rochester, Mus. Comp. Zoology, Cambridge, Mass. (41). 1896. **E**
Eastman, Prof. J. R., U. S. Naval Observatory, Washington, D. C. (26). 1879. **A**
Eaton, Prof. James R., Liberty, Mo. (29). 1885. **C B E**
Eccles, Robert G., M.D., 191 Dean St., Brooklyn, N. Y. (31). 1894. **F C**
Eddy, Prof. H. T., Engineering and Mechanics, The Univ. of Minnesota, Minneapolis, Minnesota (24). 1875. **A B D**
Edison, Thos. A., Orange, N. J. (27). 1878. **B**
Egleston, Prof. Thomas, 35 W. Washington Square, New York, N. Y. (27). 1879. **C D E**
Eichelberger, William Snyder, Ph.D., Nautical Almanac Office, U. S. Naval Observ., Washington, D. C. (41). 1896. **A**
Eimbeck, William, U. S. C. and G. Survey, Washington, D. C. (17). 1874. **A B D**
Elkin, William L., Yale Coll. Observ., New Haven, Conn. (33). 1885. **A**
Ely, Theo. N., Chief of Motive Power, Penn. R. R., Broad St. Station, Philadelphia, Pa. (29). 1886.
Emerson, Prof. Benjamin K., Box 203, Amherst, Mass. (19). 1877. **E F**
Emery, Charles E., Bennett Building, New York, N. Y. (34). 1886. **D B A**
EMMONS, S. F., U. S. Geol. Survey, Washington, D. C. (26). 1879. **E**
Engelmann, George J., M.D., 336 Beacon St., Boston, Mass. (25). 1875. **F H**
Ewell, Ervin E., 3644 Thirteenth St., N. W., Washington, D. C. (40). 1896. **C**
Eyerman, John, "Oakhurst," Easton, Pa. (33). 1889. **E C**

Fairbanks, Henry, Ph.D., St. Johnsbury, Vt. (14). 1874. **B D A**
Fairchild, Prof. H. L., University of Rochester, Rochester, N. Y. (28). 1883. **E F**
Fanning, John T., Consulting Eng., Kasota Block, Minneapolis, Minn. (29). 1885. **D**
Fargis, Rev. Geo. A., Georgetown College, Georgetown, D. C. (40). 1892.
Farlow, Dr. W. G., 24 Quincy St., Cambridge, Mass. (20). 1875. **G**
Farquhar, Henry, Dep't of Agric., Washington, D. C. (33). 1886. **A I G B**

Fernow, Bernhard E., Chief of Forestry Division, Dep't of Agriculture, Washington, D. C. (31). 1887. **G I**

Ferry, Ervin S., Univ. of Wisconsin, Madison, Wis. (41). 1896.

Firmstone, F., Easton, Pa. (33). 1887. **D**

Fiske, Thos. S., A.M., Ph.D., Columbia College, New York, N. Y. (38). 1891. **A**

Fitch, Edward H., Jefferson, Ashtabula Co., Ohio (11). 1874. **I E**

Flather, Prof. John J., 160 South St., Lafayette, Ind. (44). 1896. **D**

Fletcher, Miss Alice C., care Peabody Museum, Cambridge, Mass. (29). 1883. **H**

Fletcher, James, Dominion Entomologist, Experimental Farm, Ottawa, Ontario, Can. (31). 1883. **F**

Fletcher, Dr. Robert, Army Medical Museum, Washington, D. C. (29). 1881. **F H**

Flint, Albert S., Washburn Observ., Madison, Wis. (30). 1887. **A**

Flint, James M., Surgeon U. S. N., Smithsonian Institution, Washington, D. C. (28). 1882. **F**

Ford, Prof. D. R., Elmira, N. Y. (41). 1894. **A B**

Fox, Oscar C., U. S. Patent Office, Washington, D. C. (36). 1891. **B D A**

Franklin, William S., Ames, Iowa (36). 1892.

FRAZER, DR. PERSIFOR, Drexel Building, Room 1042, Philadelphia, Pa. (24). 1879. **E C**

Frazier, Prof. B. W., The Lehigh University, So. Bethlehem, Pa. (24). 1882. **E C**

Frear, Wm., State College, Centre Co., Pa. (33). 1886. **C**

Freer, Prof. Paul C., Ann Arbor, Mich. (39). 1891. **C**

French, Prof. Thomas, jr., Ridgeway Ave., Avondale, Cincinnati, Ohio (30). 1883. **B**

Frisby, Prof. Edgar, U. S. N. Observ., Washington, D. C. (28). 1880. **A**

Frost, Edwin Brant, Hanover, N. H. (38). 1890. **A B**

Frost, Howard V., Ph.D., Arlington, Mass. (38). 1895. **C**

Fuller, Andrew S., Ridgewood, Bergen Co., N. J. (24). 1882. **F**

Fuller, Prof. Homer T., Pres. Drury Coll., Springfield, Mo. (35). 1891. **C E**

Fulton, Robert B., Chancellor Univ. of Miss., Prof. of Physics and Astronomy, University, Miss. (21). 1887. **B A**

Gaffield, Thomas, 54 Allen St., Boston, Mass. (29). 1889. **C B**

Gage, Prof. Simon Henry, Ithaca, N. Y. (28). 1881. **F**

Galbraith, Prof. John, Toronto, Ontario, Can. (38). 1889.

Galloway, B. T., Dep't of Agriculture, Washington, D. C. (37). 1890. **G**

Gibbs, Prof. J. Willard, New Haven, Conn. (33). 1885. **B**

Gilbert, G. K., U. S. Geol. Survey, Washington, D. C. (18). 1874. **E**

Gill, Adam Capen, Cornell Univ., Ithaca, N. Y. (38). 1894. **E**

Gill, Augustus Herman, Mass. Inst. Technology, Back Bay, Boston, Mass. (44). 1896. **C**

Gill, Prof. Theo., Columbian Univ., Washington, D. C. (17). 1874. **F**

Gillette, Clarence P., Fort Collins, Col. (37). 1893.
Gillman, Henry, 183 Fort St., West, Detroit, Mich. (24). 1875. **H F**
Gilman, Daniel C., President Johns Hopkins University, Baltimore, Md. (10). 1875. **E H**
Glenn, William, 1348 Block St., Baltimore, Md. (33). 1893. **C**
Goessman, Prof. C. A., Mass. Agricultural College, Amherst, Mass. (18). 1875. **C**
Goff, E. S., 1118 University Ave., Madison, Wis. (35). 1889.
Gold, Theodore S., West Cornwall, Conn. (4). 1887. **B C**
Goldschmidt, S. A., Ph.D., 43 Sedgwick St., Brooklyn, N. Y. (24). 1880. **C E B**
Goldsmith, Edw., 658 No. 10th St., Philadelphia, Pa. (29). 1892. **C B**
Gooch, Frank A., Yale College, New Haven, Conn. (25). 1880. **C**
Goodale, Prof. G. L., Botanic Gardens, Cambridge, Mass. (18). 1875. **G**
Goodfellow, Edward, Ass't U. S. Coast and Geodetic Survey, Washington, D. C. (24). 1879. **A H**
Goss, Prof. Wm. F. M., Lafayette, Ind. (39). 1896.
GRANT, MRS. MARY J., 36 Division St., Danbury, Conn. (23). 1874. **A**
Grant, Ulysses S., Ph.D., Geol. Survey of Minnesota, Minneapolis, Minn. (39). 1893. **E**
Gratacap, L. P., Ph.B., 77th St. and 8th Ave., New York, N. Y. (27). 1884. **C E F**
Gray, Prof. Thomas, Terre Haute, Ind. (38). 1889.
Green, Arthur L., Purdue Univ., Lafayette, Ind. (33). 1888. **C**
GREEN, TRAILL, M.D., Easton, Pa. (1). 1874. **C F**
Grimes, J. Stanley, Room 18, 115 Monroe St., care Newark Life Ins. Co., Chicago, Ill. (17). 1874. **E H**
Grinnell, George Bird, 40 Park Row, New York, N. Y. (25). 1885. **F E**
Griswold, Leon Stacy, 238 Boston St., Dorchester, Mass. (38). 1893. **E**

Hague, Arnold, U. S. Geol. Survey, Washington, D. C. (26). 1879.
Haines, Reuben, Haines and Chew St., Germantown, Philadelphia, Pa. (27). 1889. **C B**
Hale, Albert C., Ph.D., No. 551 Putnam Ave., Brooklyn, N. Y. (29). 1886. **C B**
Hale, Geo. E., Director of the Observatory, Univ. of Chicago, Chicago, Ill. (37). 1891. **A B C**
Hale, William H., Ph.D., 40 First Place, Brooklyn, N. Y. (19). 1874. **I F H C B E A**
Haliburton, R. G., Q.C., 99 State St., Boston, Mass. (43). 1895. **H**
Hall, Arthur G., 36 Oakland Ave., Ann Arbor, Mich. (41). 1896. **A B**
Hall, Prof. Asaph, 2715 N St., Georgetown, D. C. (25). 1877. **A**
Hall, Asaph, jr., Univ. of Mich., Ann Arbor, Mich. (38). 1890. **A**
Hall, Prof. C. W., Dean Coll. Eng. Met. and Mechan. Arts, University of Minnesota, Minneapolis, Minn. (28). 1883. **D E**
Hall, Prof. Edwin H., 5 Avon St., Cambridge, Mass. (29). 1881. **B**
Hall, Prof. Lyman B., Haverford College, Haverford, Pa. (31). 1884. **C**

Hallock, Albert P., Ph.D., 440 First Ave., New York, N. Y. (31). 1896. **C**

Hallock, Dr. Wm., Columbia Univ., New York, N. Y. (40). 1893. **B E**

Hallowell, Miss Susan M., Wellesley Coll., Wellesley, Mass. (38). 1890. **G**

Halsted, Byron D., New Jersey Agricultural Experiment Station, New Brunswick, N. J. (29). 1883. **G**

Halsted, Prof. George Bruce, Austin, Texas (43). 1896.

Hambach, Dr. G., 1319 Lami St., St. Louis, Mo. (26). 1891. **F E**

HANAMAN, C. E., Troy, N. Y. (19). 1883. **F**

Hardy, Prof. A. S., Dartmouth College, Hanover, N. H. (28). 1883. **A**

Hargitt, Prof. Charles W., Syracuse Univ., Syracuse, N. Y. (38). 1891. **F**

HARKNESS, PROF. WILLIAM, U. S. N. Observatory, Washington, D. C. (26). 1878. **A B C D**

Harris, Abram Winegardner, Sc.D., Pres. Maine State College, Orono, Me. (40). 1895. **C**

Harris, Prof. E. P., Amherst College, Amherst, Mass. (44). 1896.

Harris, Gilbert D., Cornell Univ., Ithaca, N. Y. (37). 1893. **F E**

Harris, Uriah R., Lieutenant U. S. N., U. S. S. Adams, care Navy Pay Office, San Francisco, Cal. (34). 1886. **A**

Harris, W. T., 1303 P St., N. W., Washington, D. C. (27). 1887. **H I**

Hart, Edw., Ph.D., Lafayette Coll., Easton, Pa. (33). 1885. **C**

Hasbrouck, Prof. I. E., 364 Carlton Ave., Brooklyn, N. Y. (23). 1874. **D A I**

Haskell, Eugene E., U. S. Engineer Office, Sault Ste. Marie, Mich. (39). 1896. **A B D**

HASTINGS, C. S., Sheffield Scientific School of Yale College, New Haven, Conn. (25). 1878. **B**

Hathaway, Prof. A. S., Rose Polytechnic Inst., Terre Haute, Ind. (41). 1893. **A**

Haynes, Prof. Henry W., 239 Beacon St., Boston, Mass. (28). 1884. **H**

Heal, Wm. E., Marion, Ind. (39). 1891. **A**

Hering, Rudolph, Civil and Sanitary Engineer, 277 Pearl St., New York, N. Y. (33). 1885. **D E I**

Herty, Chas. Holmes, Ph.D., Univ. of Georgia, Athens, Ga. (42). 1895. **C**

Hervey, Rev. A. B., Bath, Me. (22). 1879. **F**

Hilgard, Prof. E. W., University of California, Berkeley, Cal. (11). 1874. **C E B**

Hill, David J., Pres. Univ. of Rochester, Rochester, N. Y. (41). 1895. **H I**

Hill, Robert Thomas, U. S. Geol. Survey, Washington, D. C. (36). 1889. **E**

Hillyer, Homer W., Ph.D., Chem. Laboratory, Univ. of Wisconsin, Madison, Wis. (42). 1896. **C**

Himes, Prof. Charles F., Carlisle, Pa. (29). 1882. **B C**

Hinrichs, Dr. Gustavus, 3132 Lafayette Ave., St. Louis, Mo. (17). 1874. **C B**

Hitchcock, Albert Spear, Manhattan, Kan. (39). 1892. **G**

HITCHCOCK, PROF. CHARLES H., Hanover, N. H. (11). 1874. **E**

Hobbs, William Herbert, Ph.D., Madison, Wis. (41). 1893. **E**

Hodges, N. D. C., 874 Broadway, New York, N. Y. (29). 1882. **B**
Hodgkins, Prof. H. L., Columbian Univ., Washington, D. C. (40). 1896. **A B**
Hoffmann, Dr. Fred., "Rundschau," P. O. Box 1680, New York, N. Y. (28). 1881. **C F**
Holden, Prof. E. S., Mt. Hamilton, Cal. (23). 1875. **A**
Holland, W. J., D.D., LL.D., Chancellor of the Western Univ. of Pa., Pittsburgh, Pa. (37). 1896. **F**
Hollick, Arthur, Columbia Univ., New York, N. Y. (31). 1892. **G E**
Holmes, Prof. Jos. A., Chapel Hill, N. C. (33). 1887. **E F**
Holmes, Wm. H., Field Columbian Mus., Chicago, Ill. (30). 1883. **H**
Holway, E. W. D., Decorah, Iowa (33). 1890. **G**
Hosea, Lewis M., Johnston Building, Cincinnati, Ohio (30). 1883. **B H**
Hotchkiss, Major Jed., Staunton, Va. (31). 1883. **E H I**
Hough, Prof. G. W., Northwestern Univ., Evanston, Ill. (15). 1874. **A**
Hough, Walter, U. S. National Museum, Washington, D. C. (38). 1890.
Hovey, Edmund O., Amer. Mus. Nat. History, New York, N. Y. (36). 1895. **C E**
Hovey, Rev. Horace C., 60 High St., Newburyport, Mass. (29). 1883. **E H**
Howard, Prof. Curtis C., 97 Jefferson Ave., Columbus, Ohio (38). 1892. **C**
Howard, Leland O., Dep't of Agric., Washington, D. C. (37). 1889. **F**
Howe, Charles S., Prof. of Mathematics, Case School of Applied Science, Cleveland, Ohio (34). 1891. **A**
Howe, Prof. Jas. Lewis, Washington and Lee Univ., Lexington, Va. (36). 1888. **C**
Howell, Edwin E., 612 17th St., N. W., Washington, D. C. (25). 1891 **E**
Hubbard, Gardiner Greene, 1328 Conn. Ave., Washington, D. C. (40). 1893. **E**
Hubbard, Henry Guernsey, 230 New Jersey Ave., Washington, D. C. (41). 1895. **F**
HUBBARD, PROF. OLIVER PAYSON, 65 W. 19th St., New York, N. Y. (1). 1896.
Hulst, Rev. Geo. D., 15 Himrod St., Brooklyn, N. Y. (29). 1887. **F**
Humphreys, W. J. (42). 1894. **B**
Hunt, Alfred E., 116 Water St., Pittsburgh, Pa. (35). 1891. **C D**
Hunter, Andrew Frederick, Barrie, Ontario, Can. (38). **B H I**
Hyatt, Prof. Alpheus, Natural History Society, Boston, Mass. (18). 1875. **E**
Hyde, Prof. E. W., Station D, Cincinnati, Ohio (25). 1881. **A**

Iddings, Joseph P., The Univ. of Chicago, Chicago, Ill. (31). 1884. **E**

Jack, John G., Jamaica Plain, Mass. (31). 1890. **G**
Jackson, Prof. Charles L , Harvard Univ., Cambridge, Mass. (44). 1895. **C**
Jackson, Robert T., 33 Gloucester St., Boston, Mass. (37). 1890. **F**
Jacobus, David S., Stevens Institute, Hoboken, N. J. (36). 1889. **D B A**
Jacoby, Harold, Columbia Univ., New York, N. Y. (38). 1891. **A**

Jacoby, Henry S., Associate Prof. of Bridge Engineering and Graphics, Cornell Univ., Ithaca, N. Y. (36). 1892. **D**
James, Jos. F., M.S., Hingham, Mass. (30). 1882. **E G**
Jastrow, Dr. Jos., Univ. of Wisconsin, Madison, Wis. (35). 1887. **H F**
Jayne, Horace F., 1826 Chestnut St., Philadelphia, Pa. (29). 1884. **F H**
Jeffries, B. Joy, M.D., 15 Chestnut St., Boston, Mass. (29). 1881. **F H**
Jenkins, Edw. H., Drawer 101, New Haven, Conn. (33). 1885. **C**
Jenks, Elisha T., Middleborough, Mass. (22). 1874. **D**
Jesup, Prof. Henry G., Dartmouth College, Hanover, N. H. (36). 1891. **F**
Jesup, Morris K., 44 Pine St., New York, N. Y. (29). 1891. **I**
Jewell, Theo. F., Commander U. S. Navy, Navy Yard, Washington, D. C. (25). 1882. **B**
Jillson, Dr. B. C., 6045 Bond St., Pittsburgh, Pa. (14). 1881. **E H F**
Johnson, John B., Washington Univ., St. Louis, Mo. (33). 1886. **D**
Johnson, Otis C., 52 Thayer St., Ann Arbor, Mich. (34). 1886. **C**
Jones, Lewis R., Burlington, Vt. (41). 1894. **G**
Jones, Prof. Marcus E., Salt Lake City, Utah (40). 1893.
Jordan, Prof. David S., Palo Alto, Menlo Park P. O., Cal. (31). 1883. **F**
Julien, A. A., New York Acad. of Sciences, New York, N. Y. (24). 1875. **E C**

Kedzie, Mrs. Nellie S., Manhattan, Kan. (34). 1890. **I F**
Kedzie, Prof. Robert C., Agricultural College, Mich. (29). 1881. **C**
Kellerman, Prof. William A., Ohio Univ., Columbus, Ohio (41). 1893. **G**
Kellicott, David S., Columbus, Ohio (31). 1883. **F**
Kemp, James F., School of Mines, Columbia Univ., New York, N. Y. (36). 1888. **E**
Kendall, Prof. E. Otis, 3826 Locust St., Philadelphia, Pa. (29). 1882. **A**
Kent, William, Passaic, N. J. (26). 1881. **D I**
Kershner, Prof. Jefferson E., Lancaster City, Pa. (29). 1883. **A B**
Kinealy, John H., Washington Univ., St. Louis, Mo. (36). 1891. **D**
King, F. H., Experiment Station, Madison, Wis. (32). 1892. **E F**
Kinnicutt, Dr. Leonard P., Polytechnic Inst., Worcester, Mass. (28). 1883. **C**
Klotz, Otto Julius, 437 Albert St., Ottawa, Ontario, Can. (38). 1889.
Knowlton, Frank H., U. S. National Museum, Washington, D. C. (33). 1893. **G E**
Kober, Geo. Martin, M.D., 1819 Q St. N. W., Washington, D. C. (40). 1896. **H**
Kunz, G. F., care Messrs. Tiffany & Co., Union Square, New York, N. Y. (29). 1883. **E H C**

Lacoe, Ralph D., Pittston, Pa. (31). 1893. **E F**
Ladd, Prof. E. F., Agricultural Coll., Fargo, No. Dakota (36). 1889. **C**
Laflamme, Prof. J. C. K., Laval Univ., Quebec, Can. (29). 1887. **E B**
LaFlesche, Francis, Indian Bureau, Interior Dep't, Washington, D. C. (33). 1885. **H**

Lamb, Daniel S., M.D., 800 10th St., N. W., Washington, D. C. (40). 1894. **H**

Landreth, Olin H., Prof. of Civil Engineering, Union College, Schenectady, N. Y. (28). 1883. **D**

Langenbeck, Karl, 27 Orchard St., Zanesville, Ohio (39). 1896. **C**

Langley, Prof. J. W., Case School of Applied Science, Cleveland, Ohio (23). 1875. **C B**

Langley, Prof. S. P., Secretary Smithsonian Institution, Washington, D. C. (18). 1874. **A B**

Lanza, Prof. Gaetano, Mass. Institute of Technology, Boston, Mass. (29). 1882. **D A B**

Larkin, Edgar L., Director Knox College Observatory, Galesburg, Ill. (28). 1883. **A**

Lattimore, Prof. S. A., University of Rochester, Rochester, N. Y. (15). 1874. **C**

Laudy, Louis H., Ph.D., School of Mines, Columbia Univ., New York, N. Y. (28). 1890. **C**

Lawrence, George N., 45 E. 21st St., New York, N. Y. (7). 1877. **F**

Lazenby, Prof. Wm. R., Columbus, Ohio (30). 1882. **B I**

Leach, Miss Mary F., Mt. Holyoke Coll., South Hadley, Mass. (44). 1896. **C**

LeBrun, Mrs. Michel, 222 West 23d St., New York, N. Y. (35). 1892. **F**

LeConte, Prof. Joseph, Univ. of Cal., Berkeley, Cal. (29). 1881. **E F**

Ledoux, Albert R., Ph.D., 9 Cliff St., New York, N. Y. (26). 1881. **C**

Leeds, Prof. Albert R., Stevens Institute, Hoboken, N. J. (23). 1874. **C F**

Lefavour, Prof. Henry, Williams Coll., Williamstown, Mass. (42). 1894.

Lehmann, G. W., Ph.D., 412 East Lombard St., Baltimore, Md. (30). 1885. **C B**

Lennon, William H., Brockport, N. Y. (31). 1894. **G C**

Lesley, Prof. J. Peter, State Geologist of Pennsylvania, 1008 Clinton St., Philadelphia, Pa. (2). 1874. **E**

Leverett, Frank, Denmark, Iowa (37). 1891. **E**

Libbey, Prof. William, jr., Princeton, N. J. (29). 1887. **E F**

Lindahl, Josua, Ph.D., Society of Natural History, Cincinnati, Ohio (40). 1892. **F E**

Lindenthal, Gustav, C.E., 45 Cedar St., New York, N. Y. (37). 1891. **I**

Lintner, J. A., N. Y. State Entomologist, Room 27, Capitol, Albany, N. Y. (22). 1874. **F**

Livermore, Wm. R., Maj. of Eng. U. S. A., P. O. Building, Boston, Mass. (38). 1895. **C**

Lloyd, John Uri, Pharmaceutical Chemist, Court and Plum Sts., Cincinnati, Ohio (38). 1890. **C F**

Lloyd, Mrs. Rachel, Box 675, Lincoln, Neb. (31). 1889. **C**

Locy, Prof. Wm. A., Lake Forest, Ill. (34). 1890. **F**

Loeb, Morris, Ph.D., 37 E. 38th St., New York, N. Y. (36). 1889. **C**

Long, Prof. John H., 40 Dearborn St., Chicago, Ill. (41). 1895. **C**

Lord, Prof. Nat. W., State Univ., Columbus, Ohio (29). 1881. **C**

Loud, Prof. Frank H., 1203 N. Tejon St., Colorado Springs, Col. (29). **A B**

Loughridge, Dr. R. H., Ass't Prof. Agric. Chem. and Agric. Geol., Univ. of California, Berkeley, Cal. (21) 1874. **E C**

Love, Edward G., 80 E. 55th St., New York, N. Y. (24). 1882. **C**

Low, Seth, President Columbia Univ., New York, N. Y. (29). 1890.

Lowell, Percival, 53 State St., Boston, Mass. (36). 1896. **A**

Lyford, Edwin F., Springfield, Mass. (33). 1896. **B C H**

Lyle, David Alexander, Captain Ordnance Dept. U. S. A., Ordnance Office, War Dept., Washington, D. C. (28). 1880. **D**

Lyon, Dr. Henry, 34 Monument Sq., Charlestown, Mass. (18). 1874.

McAdie, Alexander George, U. S. Weather Bureau, Washington, D. C. (40). 1892. **B**

McCauley, Major C. A. H., Q. M., U. S. A., 1428 Arch St., Philadelphia, Pa. (29). 1881.

McClintock, Emory, Morristown, N. J. (43). 1895. **A**

McCreath, Andrew S., 223 Market St., Harrisburg, Pa. (33). 1889. **C E**

McCurdy, Chas. W., Sc.D., Prof. of Chem., Univ. of Idaho, Moscow, Idaho (35). 1895. **F E**

McDonnell, Prof. Henry B., College Park, Md. (40). 1893. **C**

McGee, Dr. Anita Newcomb, Bureau of American Ethnology, Washington, D. C. (37). 1892. **H**

McGee, W J, Bureau of American Ethnology, Washington, D. C. (27). 1882. **H E**

McGill, John T., Ph.D., Vanderbilt Univ., Nashville, Tenn. (36). 1888. **C**

McGregory, Prof. J. F., Colgate Univ., Hamilton, N. Y. (35). 1892. **C**

McMahon, James, Ithaca, N. Y. (36). 1891. **A**

MacMillan, Prof. Conway, Univ. of Minnesota, Minneapolis, Minn. (42). 1894. **G**

McMurtrie, William, 106 Wall St., New York, N. Y. (22). 1874. **C**

McNeill, Malcolm, Lake Forest, Ill. (32). 1885. **A**

McRae, Austin Lee, Consulting Electrical Eng., 306 Oriel Building, St. Louis, Mo. (39). 1891. **B**

Mabery, Prof. C. F., Case School of Applied Science, Cleveland, Ohio (29). 1881. **C**

Macbride, Prof. Thomas H., Iowa City, Iowa (38). 1890. **G**

Macfarlane, Prof. A., Lehigh Univ., So. Bethlehem, Pa. (34). 1886. **B A**

Macloskie, Prof. George, College of New Jersey, Princeton, N. J. (25). 1882. **F**

Magie, Prof. Wm., F., Coll., of New Jersey, Princeton, N. J. (35). 1887.

MANN, B. PICKMAN, 1918 Sunderland Place, Washington, D. C. (22). 1874 **I F**

Marcy, Oliver, LL.D., Evanston, Ill. (10). 1874. **E**

Mark, Prof. E. H., Louisville, Ky. (39). 1893. **B**

Marlatt, Charles L., 1st Ass't Entomologist, Dep't of Agric., Washington, D. C. (40). 1895. **F**

Marsh, Prof. C. Dwight, Ripon, Wis. (34). 1893. **F E**
MARSH, PROF. O. C., Yale College, New Haven, Conn. (15). 1874. **F H**
Martin, Artemas, U. S. Coast Survey, Washington, D. C. (38). 1890. **A**
Martin, Prof. Daniel S., 236 West 4th St., New York, N. Y. (23). 1879. **E F**
Martin, Miss Lillie J., Girls' High School, San Francisco, Cal. (32). 1886. **F C**
Martin, Prof. Wm. J., Davidson College, N. C. (31). 1884. **C E**
Marvin, C. F., U. S. Weather Bureau, Washington, D. C. (39). 1892. **B**
Marvin, Frank O., Univ. of Kansas, Lawrence, Kan. (35). 1894. **D**
Mason, Dr. William P., Prof. Rensselaer Polytechnic Inst., Troy, N. Y. (31). 1886. **C**
Matthews, Dr. Washington, 1262 New Hampshire Ave., cor. 21st St., N. W., Washington, D. C. (37). 1888. **H**
Mayer, Prof. A. M., Stevens Inst. of Technology, Hoboken, N. J. (19). 1874.
Meehan, Thomas, Germantown, Pa. (17). 1875 **G**
Mees, Prof. Carl Leo, Rose Polytechnic Inst., Terre Haute, Ind. (24). 1876. **B C**
Mell, Prof. P. H., Polytechnic Inst., Auburn, Ala. (39). 1895. **E G**
Mendenhall, Prof. T. C., President Worcester Polytechnic Institute, Worcester, Mass. (20). 1874. **B**
Menocal, Anicito G., C. E., U. S. N., Navy Yard, Washington, D. C. (36). 1888. **D**
Mercer, H. C., Doylestown, Bucks Co., Pa. (41). 1893. **H**
Merrill, Frederick J. H., Ph.D., Ass't Director New York State Museum, Albany, N. Y. (35). 1887. **E**
Merriman, C. C., 1910 Surf St., Lake View, Chicago, Ill. (29). 1880. **F**
Merriman, Prof. Mansfield, So. Bethlehem, Pa. (32). 1885. **A D**
Merritt, Ernest, Ithaca, N. Y. (33). 1890. **B**
Metcalf, William, Pittsburgh, Pa. (33). 1894. **D**
Michael, Mrs. Helen Abbott, 44 Mount Vernon St., Boston, Mass. (33). 1885. **C F**
Michelson, Prof. A. A., Chicago Univ., Chicago, Ill. (26). 1879. **B**
Miles, Prof. Manly, Lansing, Mich. (29). 1890. **F I**
Miller, Prof. William S., Univ. of Wis., Madison, Wis. (42). 1894. **F**
Mills, James, M.A., Guelph, Ontario, Can. (31). 1895. **I C**
Mills, Prof. Wesley, McGill College, Montreal, P. Q., Can. (31). 1886. **F H**
Minot, Dr. Charles Sedgwick, Harvard Medical School, Back Bay, Boston, Mass. (28). 1880. **F**
Minot, Francis, M.D., Readville, Mass. (29). 1884.
Mixter, Prof. Wm. G., New Haven, Conn. (30). 1882. **C**
Mohr, Dr. Charles, Mobile, Ala. (40). 1895. **G**
Moler, Geo. S., 106 University Ave., Ithaca, N. Y. (38). 1892.
Moody, Robert O., M.D., Fair Haven Heights, New Haven, Conn. (35). 1892. **F**
Mooney, James, Bureau of Ethnology, Washington, D. C. (38). 1890. **H**

Moore, E. Hastings, The Univ. of Chicago, Chicago, Ill. (39). 1891. **A**
Moore, Prof. J. W., M.D., Lafayette College, Easton, Pa. (22). 1874. **B D A**
Moore, Veranus A., M.D., Ithaca, N. Y. (40). 1892. **F**
Moorehead, Warren K., Ohio State Univ., Columbus, Ohio (38). 1890. **H**
Moreland, Prof. S. T., Lexington, Va. (33). 1894. **B D**
Morley, Prof. Edward W., 23 Cutler St., Cleveland, Ohio (18). 1876. **C B E**
Morse, Prof. E. S., Salem, Mass. (18). 1874. **F H**
Morton, H., Stevens Institute Technology, Hoboken, N. J. (18). 1875. **B C**
Moser, Lieut. Comd'r Jeff. F., U. S. N., Com'dg U. S. F. S. Str. Albatross, Navy Pay Office, San Francisco, Cal. (28). 1889. **E**
Moses, Prof. Thomas F., Urbana University, Urbana, Ohio (25). 1883. **H F**
Munroe, Prof. C. E., Columbian Univ., Washington, D. C. (22). 1874. **C**
Murdoch, John, Rock, Plymouth Co., Mass. (29). 1886. **F H**
Murtfeldt, Miss Mary E., Kirkwood, Mo. (27). 1881. **F**
Myers, John A., Agric. Exper. Station, Morgantown, W. Va. (30). 1889. **C**

Nagle, Prof. James C., A. and M. Coll., College Station, Texas (40). 1893. **D B**
Nason, Frank L., 5 Union St., New Brunswick, N. J. (36). 1888. **E**
Nef, J. U., Univ. of Chicago, Chicago, Ill. (39). 1891. **C**
Nelson, Prof. A. B., Centre College, Danville, Ky. (30). 1882. **A B D**
Newcomb, Prof. S., Navy Dep't, Washington, D. C. (13). 1874. **A B**
Newcombe, Frederick Chas., 51 E. Liberty St., Ann Arbor, Mich. (43). 1896. **G**
Newell, F. H., U. S. Geol. Survey, Washington, D. C. (40). 1893.
Newell, William Wells, Editor Journal American Folk Lore, Cambridge, Mass. (41). 1893. **H**
Nichols, Ernest Fox, Hamilton, N. Y. (41). 1893. **B**
Nichols, E. L., Ph.D., Cornell Univ., Ithaca, N. Y. (28). 1881. **B C**
Nicholson, Prof. H. H., Box 675, Lincoln, Neb. (36). 1888.
Niles, Prof. W. H., Cambridge, Mass. (16). 1874. **E**
NORTON, PROF. THOMAS H., Univ. of Cincinnati, Cincinnati, Ohio (35). 1887. **C**
Novy, Dr. Frederick G., Univ. of Michigan, Ann Arbor, Mich. (36). 1889. **C**
Noyes, Prof. Wm. A., Rose Polytechnic Inst., Terre Haute, Ind. (32). 1885. **C**
Nuttall, Mrs. Zelia, care Peabody Museum, Cambridge, Mass. (35). 1887. **H**
Nutting, Prof. Charles C., State Univ. of Iowa, Iowa City, Iowa (40). 1892. **F**

Ogden, Herbert G., U. S. Coast and G. Survey, Washington, D. C. (38). 1891. **E**

Ordway, Prof. John M., Tulane Univ., New Orleans, La. (9). 1875. C
Orndorff, Dr. William Ridgely, Cornell Univ., Ithaca, N. Y. (41). 1893. C
Orr, William, jr. 30 Firglade Ave., Springfield, Mass. (39). 1895. F B
Orton, Prof. Edward, President Ohio Agricultural and Mechanical College, Columbus, Ohio (19). 1875. E
Osborn, Henry F., Columbia Univ., New York, N. Y. (29). 1888. F
Osborn, Herbert, Ames, Iowa (32). 1884. F
Osmond, Prof. I. Thornton, State College, Centre Co., Pa. (33). 1889. B A C

Packard, Dr. A. S., 115 Angell St., Providence, R. I. (16). 1875. F E
Paine, Cyrus F., 806 Granite Building, Rochester, N. Y. (12). 1874. B A
Palache, Charles, University Museum, Cambridge, Mass. (44). 1896. E
Palfray, Hon. Charles W., Salem, Mass. (21). 1874.
Pammel, Prof. L. H., Iowa Agricultural College, Ames, Iowa (39). 1892.
Parke, John G., Gen. U. S. A., 16 Lafayette Square, Washington, D. C. (29). 1881. D
PARKHURST, HENRY M., 173 Gates Ave., Brooklyn, N. Y. (23). 1874. A
Parsons, Prof. C. Lathrop, Durham, N. H. (41). 1896.
Patrick, Geo. E., Ames, Iowa (36). 1890. C
Patterson, Harry J., College Park, Prince George's Co., Md. (36). 1890. C
Paul, Prof. Henry M., U. S. Naval Observatory, Washington, D. C. (33). 1885. A B
Peabody, Selim H., 4200 Berkeley Ave., Chicago, Ill. (17). 1885. D B F
Pedrick, Wm. R., Lawrence, Mass. (22). 1875.
Peet, Rev. Stephen D., Good Hope, Ill. (24). 1881. H
Penrose, Dr. R. A. F., 1331 Spruce St., Philadelphia, Pa. (38). 1890. E
Perkins, Prof. George H., Burlington, Vt. (17). 1882. H F E
Perry, Arthur C., 226 Halsey St., Brooklyn, N. Y. (43). 1896. A B
Peter, Alfred M., 236 E. Maxwell St., Lexington, Ky. (29). 1890. C
Peters, Edw. T., P. O. Box 265, Washington, D. C. (33). 1889. I
Pettee, Prof. Wm. H., 52 Thompson St., Ann Arbor, Mich. (24). 1875. E
Phillips, Prof. A. W., New Haven, Conn. (24). 1879.
Phillips, Prof. Francis C., Western Univ., Allegheny, Pa. (36). 1889. C
Phillips, Dr. Wm. A., Evanston, Ill. (41). 1895. H
Pickering, Prof. E. C., Director of Observatory, Cambridge, Mass. (18). 1875. A B
Pierce, Perry Benj., U. S. Patent Office, Washington, D. C. (40). 1895. H
Pillsbury, Prof. John H., Stoneham, Mass. (28). 1885. F H
Platt, Franklin, Ass't Geologist, 2nd Geol. Survey of Pa., 1617 Chestnut St., Philadelphia, Pa. (27). 1882. E
Pohlman, Dr. Julius, Buffalo, N. Y. (32). 1884. E F
Porter, Thos. C., LL.D., Lafayette College, Easton, Pa. (33). 1887. G
Powell, Major J. W., Washington, D. C. (23). 1875. E H
Power, Frederick B., care Messrs. Burroughs, Wellcome & Co., 42 Snow Hill, London, E. C., Eng. (31). 1887. C

Prentiss, D. Webster, M.D., 1101 14th St., N. W., Washington, D. C. (29). 1882. **F**

Prentiss, Robert W., Prof. of Mathematics and Astronomy, Rutgers College, New Brunswick, N. J. (40). 1891. **A**

Prescott, Prof. Albert B., Ann Arbor, Mich. (23). 1875. **C**

Prosser, Charles S., Prof. of Geology, Union Coll., Schenectady, N. Y. (33). 1891. **E F**

Pulsifer, Wm. H., Newton Centre, Mass. (26). 1879. **A H**

Pupin, Dr. M. I., Columbia Univ., New York, N. Y. (44). 1896. **B**

Putnam, Prof. F. W., Curator Peabody Museum American Archæology and Ethnology, Cambridge, Mass.; Curator Dept. Anthropology, Amer. Museum Nat. History, Central Park, New York, N. Y. (Address as Permanent Secretary A. A. A. S., Salem, Mass.) (10). 1874. **H**

Pynchon, Rev. T. R., Trinity College, Hartford, Conn. (23). 1875.

Rathbun, Richard, care Smithsonian Institution, Washington, D. C. (40). 1892. **F**

Raymond, Rossiter W., 13 Burling Slip, New York, N. Y. (15). 1875. **E I**

Raymond, Prof. Wm. G., Rensselaer Polytechnic Inst., Troy, N. Y. (44). 1896. **D**

Rees, Prof. John K., Columbia Univ., New York, N. Y. (26). 1878. **A E B**

Reese, Charles L., 1801 Linden Ave., Baltimore, Md. (39). 1892. **C**

Reese, Jacob, 400 Chestnut St., Philadelphia, Pa. (33). 1891. **D B**

Reid, Harry Fielding, Johns Hopkins Univ., Baltimore, Md. (36). 1893. **B**

Remsen, Prof. Ira, Johns Hopkins Univ., Baltimore, Md. (22). 1875. **C**

Rice, Prof. Wm. North, Wesleyan University, Middletown, Conn. (18). 1874. **E F**

Richards, Prof. Charles B., 137 Edwards St., New Haven, Conn. (33). 1885. **D**

Richards, Edgar, 1621 H St., Washington, D. C. (31). 1886. **C**

Richards, Prof. Robert H., Mass. Inst. Tech., Back Bay, Boston, Mass. (22). 1875. **D**

Richards, Mrs. Robert H., Prof. Mass. Inst. of Tech., Back Bay, Boston, Mass. (23). 1878. **C**

Richardson, Clifford, Sup't of Tests, Barber Asphalt Paving Co., Long Island City, N. Y. (30). 1884. **C**

Ricketts, Prof. Palmer C., 17 1st St., Troy, N. Y. (33). 1887. **D A**

Ricketts, Prof. Pierre de Peyster, 104 John St., New York, N. Y. (26). 1880. **C D E**

Risteen, Allen D., Hartford, Conn. (38). 1890. **A B D**

Ritchie, E. S., Newton Highlands, Mass. (10). 1877. **B**

Robinson, Benjamin Lincoln, Curator Harvard Herbarium, Cambridge, Mass. (41). 1893. **G**

Robinson, Prof. Franklin C., Bowdoin College, Brunswick, Me. (29). 1889. **C D**

Robinson, Prof. S. W., 1353 Highland St., Columbus, Ohio (30). 1883. **D B A**

Rockwell, Gen. Alfred P., Manchester, Mass. (10). 1882. **E**
Rockwell, Chas. H., Box 293, Tarrytown, N. Y. (28). 1883. **A D**
Rockwood, Prof. Charles G., jr., College of New Jersey, Princeton, N. J. (20). 1874. **A E B D**
Rogers, Prof. W. A., Colby Univ., Waterville, Me. (15). 1875. **A B D**
Rominger, Dr. Carl, Ann Arbor, Mich. (21). 1879. **E**
Rood, Prof. O. N., Columbia Univ., New York, N. Y. (14). 1875. **B**
Rosa, Edward Bennett, Prof. of Physics, Wesleyan Univ., Middletown, Conn. (39). 1892. **A B**
Ross, Prof. Edward A., Stanford, Cal. (41). 1894. **I**
Ross, Waldo O., 1 Chestnut St., Boston, Mass. (29). 1882.
Rotch, A. Lawrence, Readville, Mass. (39). 1896.
Rowland, Prof. Henry A., Baltimore, Md. (29). 1880. **B**
Rowlee, W. W., Cornell Univ., Ithaca, N. Y. (41). 1894. **G**
Runkle, Prof. J. D., Mass. Institute of Technology, Boston, Mass. (2). 1875. **A D**
Rusby, Henry H., M.D., College of Pharmacy, 211 E. 23d St., New York, N. Y. (36). 1890. **G**
Russell, Prof. H. L., University of Wisconsin, Madison, Wis. (41). 1894. **G**
Russell, I. C., Univ. of Mich., Ann Arbor, Mich. (25). 1882. **E**
Ryan, Harris J., Cornell Univ., Ithaca, N. Y. (38). 1890. **B**

Sadtler, Sam'l P., 1042 Drexel Building, Philadelphia, Pa. (22). 1875. **C**
Saegmuller, G. N., 132 Maryland Ave., S. W., Washington, D. C. (38). 1891. **A B**
Safford, Dr. James M., Nashville, Tenn. (6). 1875. **E C F**
Safford, Prof. Truman H., Williamstown, Mass. (41). 1892. **A**
Salisbury, Prof. R. D., Chicago Univ., Chicago, Ill. (37). 1890. **B E**
Salmon, Daniel E., Dep't of Agric., Washington, D. C. (31). 1885. **F**
Sampson, Commander W. T., U. S. N., Navy Dept., Washington, D. C. (25). 1881. **B A**
Saunders, Prof. Charles E., 32 St. Mary St., Toronto, Ontario, Can. (41). 1895. **C**
Saunders, William, Director Canadian Experimental Farms, Ottawa, Ontario, Can. (17). 1874. **F**
Saville, Marshall H., Amer. Mus. Nat. Hist., Central Park, New York, N. Y. (39). 1892. **H**
SCHAEBERLE, J. M., Astronomer in the Lick Observatory, San José, Cal. (34). 1886. **A**
Schanck, Prof. J. Stillwell, Princeton, New Jersey (4). 1882. **C B H**
Schott, Charles A., U. S. Coast and Geodetic Survey Office, Washington, D. C. (8). 1874. **A**
Schurman, Jacob G., Pres. Cornell Univ., Ithaca, N. Y. (41). 1895. **H**
Schwarz, E. A., 230 New Jersey Ave., Washington, D. C. (29). 1895. **F**
Schweinitz, Dr. E. A. de, Dep't of Agriculture, Washington, D. C. (36). 1889. **C**

Schweitzer, Prof. Paul, State University of Missouri, Columbia, Mo. (24). 1877. C B

Scovell, M. A., Director Kentucky Agricultural Experiment Station, Lexington, Ky. (35). 1887.

SCUDDER, SAMUEL H., Cambridge, Mass. (13). 1874. F

Scull, Miss S. A., 1100 M St., N. W., Washington, D. C. (40). 1895. H

Seaman, W. H., Chemist, 1424 11th St. N. W., Washington, D. C. (23). 1874. C F

Searle, Prof. Geo. M., Catholic Univ., Washington, D. C. (39). 1891. A

See, Horace, 1 Broadway, New York, N. Y. (34). 1886. D

Seymour, Arthur Bliss, Cambridge, Mass. (36). 1890. G

Seymour, Paul Henry, 479 Second Ave., Detroit, Mich. (44). 1896. C

Sharples, Stephen P., 13 Broad St., Boston, Mass. (29). 1884. C

Shaw, Prof. James Byrnie, 1030 Grove St., Jacksonville, Ill. (43). 1896. A

Sheldon, Samuel, A.M., Ph.D., Polytechnic Inst., Brooklyn, N. Y. (42). 1894. B

Shelton, Prof. Edward M., Dep't of Agric., Brisbane, Queensland, Australia (32). 1892. F

Shimer, Porter W., E.M., Easton, Pa. (38). 1889. C

Shufeldt, Dr. R. W., Smithsonian Institution, Washington, D. C. (40). 1892. F

Sias, Solomon, M.D., Schoharie, Schoharie Co., N. Y. (10). 1874.

Sigsbee, Chas. D., Com'd'r U. S. N., U. S. Hydrographic Office, Washington, D. C. (28). 1882. D E

Simon, Dr. Wm., 1348 Block St., Baltimore, Md. (29). 1895. C

Skilton, James A., 115 Broadway, New York, N. Y. (43). 1895. I

Skinner, Aaron N., U. S. Naval Observ., Washington, D. C. (40). 1893. A

Skinner, Joseph J., Massachusetts Inst. Technology, Boston, Mass. (23). 1880. B

Smith, Alex., Ph.D., The Univ. of Chicago, Chicago, Ill. (40). 1892. C

Smith, Prof. Chas. J., 35 Adelbert St., Cleveland, Ohio (32). 1885. A B

Smith, Prof. Edgar F., Univ. of Penn., Philadelphia, Pa. (33). 1891. C

Smith, Edwin, Rockville, Montgomery Co., Md. (30). 1882. A B

Smith, Prof. Erastus G., Beloit College, Beloit, Wis. (34). 1887. C

Smith, Erwin F., Dep't of Agric., Washington, D. C. (34). 1890. G

Smith, Prof. Eugene A., University, Ala. (20). 1877. E C

Smith, Harlan I., Amer. Mus. Nat. History, Central Park, New York, N. Y. (41). 1896. H

Smith, James Perrin, Ph.D., Ass't Prof. of Paleontology, Leland Stanford Junior Univ., Palo Alto, Cal. (37). 1894. C E

Smith, John B., Professor of Entomology, Rutgers College, New Brunswick, N. J. (32). 1884. F

SMITH, QUINTIUS C., M.D., No. 617 Colo. St., Austin, Texas (26). 1881. F

Smith, Dr. Theobald, 41 Orchard St., Jamaica Plain, Mass. (35). 1887. F

Smock, Prof. John Conover, Trenton, N. J. (23). 1879. E

Smyth, C. H., jr., Clinton, N. Y. (38). 1894. E

Snow, Prof. Benj. W., Madison, Wis. (35). 1889. **B**
Snow, Prof. F. H., Lawrence, Kan. (29). 1881. **F E**
Snow, Julia W., La Salle, Ill. (39). 1892. **F**
Snyder, Henry, B.Sc., Miami Univ., Oxford, Ohio (30). 1888. **B C**
Soule, R. H., Roanoke, Va. (33). 1886. **D**
Spencer, Prof. J. William, 1320 Corcoran St., Washington, D. C. (28). 1882. **E**
SPENZER, JOHN G., M.D., 370 Central Ave., Cleveland, Ohio (37). 1895. **C**
Springer, Dr. Alfred, Box 621, Cincinnati, Ohio (24). 1880. **C**
Squibb, Edward R., M.D., 152 Columbia Heights, Brooklyn, N. Y. (43). 1896.
Starr, Frederick, Ph.D., Prof. Univ. of Chicago, Chicago, Ill. (36). 1892. **H E**
Stearns, Robert E. C., Shaffer House, 525 Sand St., Los Angeles, Cal. (18). 1874. **F**
Stedman, John M., Prof. of Entomology, Univ. of the State of Missouri, Columbia, Mo. (40). 1892. **F**
Steinmetz, Chas. Proteus, General Electric Co., Schenectady, N. Y. (40). 1895. **B**
Stejneger, Leonhard, Curator Dept. of Reptiles, National Museum, Washington, D. C. (40). 1892. **F**
STEPHENS, W. HUDSON, Lowville, N. Y. (18). 1874. **E H**
Sternberg, George M., M.D., LL.D., Surgeon General U. S. A., War Dep't, Washington, D. C. (24). 1880. **F**
Stevens, Prof. W. LeConte, Rensselaer Polytechnic Inst., Troy, N. Y. (29). 1882. **B**
Stevenson, Mrs. Cornelius, 237 So. 21st St., Philadelphia, Pa. (33). 1895. **H**
Stevenson, Prof. John J., Univ. Heights, New York, N. Y. (36). 1888. **E**
Stevenson, Mrs. Matilda C., Bureau of Ethnology, Washington, D. C. (41). 1893. **H**
Stieglitz, Dr. Julius, Univ. of Chicago, Chicago, Ill. (39). 1895. **C**
Stiles, Dr. Chas. W., Dept. of Agric., Washington, D. C. (40). 1892. **F**
Stoddard, Prof. John T., Smith College, Northampton, Mass. (35). 1889. **B C**
Stokes, Henry Newlin, Ph.D., U. S. Geol. Survey, Washington, D. C. (38). 1891. **C E**
Stone, Ormond, Director Leander McCormick Observatory, University of Virginia, Va. (24). 1876. **A**
Stone, Prof. Winthrop E., Purdue Univ., Lafayette, Ind. (39). 1891. **C**
Story, Prof. Wm. E., Clark Univ., Worcester, Mass. (29). 1881. **A**
Stowell, Prof. T. B., Potsdam, N. Y. (28). 1885. **F**
Stuart, Prof. A. P. S., Lincoln, Nebraska (21). 1874. **C**
Sturgis, Wm. C., 384 Whitney Ave., New Haven, Conn. (40). 1892. **G**
Sturtevant, E. Lewis, M.D., So. Framingham, Mass. (29). 1882. **G**
Swingle, W. T., Eustis, Florida (40). 1892. **G**

Tainter, Charles Sumner, Central Power Station, Washington, D. C. (29). 1881. **B D A**

Talbot, Henry P., Prof. Analytical Chemistry, Mass. Inst. Technology, Back Bay, Boston, Mass. (44). 1896. **C**

Taylor, Thos., M.D., Department of Agriculture, Washington, D. C. (29). 1885. **F C**

Tesla, Nikola, LL.D., 55 W. 27th St., New York, N. Y. (43). 1895. **B**

Thomas, Benj. F., Ph.D., State Univ., Columbus, Ohio (29). 1882. **B A**

Thomas, Prof. M. B., Crawfordsville, Ind. (41). 1894. **G**

Thompson, Joseph Osgood, Amherst, Mass. (41). 1893.

Thomson, Elihu, Thomson-Houston Electric Co., Lynn, Mass. (37). 1888. **B**

Thomson, Wm., M.D., 1426 Walnut St., Philadelphia, Pa. (33). 1885. **B**

Thruston, Gates Phillips, Nashville, Tenn. (38). 1890. **H**

Thruston, R. C. Ballard, care Ballard & Ballard Co., Louisville, Ky. (36). 1896. **E**

Thurston, Prof. R. H., Sibley College, Cornell University, Ithaca, N. Y. (28). 1875. **D**

Tittmann, Otto H., U. S. Coast and Geodetic Survey Office, Washington, D. C. (24). 1888. **A**

Todd, Prof. David P., Director Lawrence Observ., Amherst College, Amherst, Mass. (27). 1881. **A B D**

Todd, Prof. James E., Box 22, Vermillion, So. Dak. (22). 1886. **E F**

Tooker, William Wallace, Sag Harbor, N. Y. (43). 1895. **H**

Tracy, Sam'l M., Agricultural College, Miss. (27). 1881. **G**

Traphagen, Frank W., Ph.D., Bozeman, Montana (35). 1889. **C F E**

Trelease, Dr. Wm., Director Missouri Botanical Gardens, St. Louis, Mo. (39). 1891. **G**

Trenholm, Hon. W. L., Pres. Amer. Surety Co., 160 Broadway, New York, N. Y. (35). 1896.

Trimble, Prof. Henry, 145 No. 10th St., Philadelphia, Pa. (34). 1889. **C**

Tucker, Willis G., M.D., Albany Med. Coll., Albany, N. Y. (29). 1888. **C**

TUCKERMAN, ALFRED, Ph.D., 342 W. 57th St., New York, N. Y. (39). 1891. **C**

Tuttle, Prof. Albert H., Univ. of Virginia, Charlottesville, Va. (17). 1874. **F**

Twitchell, E., 10 Bellevue Ave., Mt. Auburn, Cincinnati, Ohio (39). 1891. **C**

Uhler, Philip R., 254 W. Hoffman St., Baltimore, Md. (19). 1874. **F E**

Uline, Edwin Burton, Lake Forest, Ill. (42). 1894. **G**

Underwood, Lucien M., Prof. of Botany, Columbia College, New York, N. Y. (33). 1885. **G**

Upham, Warren, Librarian of the Minnesota Historical Society, St. Paul, Minn. (25). 1880. **E**

Upton, Winslow, Brown Univ., Providence, R. I. (29). 1883. **A**

Van Dyck, Prof. Francis Cuyler, New Brunswick, N. J. (28). 1882. **B C F**

Van Hise, Charles R., Univ. of Wisconsin, Madison, Wis. (37). 1890.

Van Vleck, Prof. John M., Wesleyan Univ., Middletown, Conn. (23). 1875. **A**

Veeder, Major Albert, M.D., Lyons, Wayne Co., N. Y. (36). 1895.

Venable, Prof. F. P., Chapel Hill, N. C. (39). 1891. **C**

Vining, Edward P., care Chas. B. Griggs, Washington St., Brookline, Mass. (32). 1887. **H**

Vogdes, A. W., Capt. 5th Art'y, Fort Mason, San Francisco, Cal. (32). 1885. **E F**

Voorhees, Louis A., Agric. Exper. Station, New Brunswick, N. J. (43). 1895. **C**

Wadsworth, Prof. M. Edward, Ph.D., Director of the Michigan Mining School, State Geologist of Michigan, Houghton, Mich. (23). 1874. **E**

Waite, M. B., Dep't of Agric., Washington, D. C. (37). 1893. **G**

Walcott, Charles D., Director U. S. Geological Survey, Washington, D. C. (25). 1882. **E F**

Waldo, Prof. Clarence A., Purdue Univ., Lafayette, Ind. (37). 1889. **A**

Waldo, Leonard, S. D., Bridgeport, Conn. (28). 1880. **A**

Wallace, Wm., Ansonia, Conn. (28). 1882.

WALLER, E., School of Mines, Columbia Univ., New York, N. Y. (23). 1874.

Walmsley, W. H., 134-136 Wabash Ave., Chicago, Ill. (28). 1883. **F**

Wanner, Atreus, York, York Co., Pa. (36). 1890. **H**

Ward, Prof. Henry A., Rochester, N. Y. (13). 1875. **F E H**

Ward, Lester F., U. S. Geological Survey, Washington, D. C. (26). 1879. **E G**

Ward, Dr. R. H., 53 Fourth St., Troy, N. Y. (17). 1874. **G F**

Ward, Samuel B., M.D., Albany, N. Y. (29). 1896. **F C A**

Ward, Wm. E., Port Chester, N. Y. (36). 1889. **D**

Warder, Prof. Robert B., Howard Univ., Washington, D. C. (19). 1881. **C B**

Warner, Prof. A. G., Leland Stanford jr. Univ., Palo Alto, Cal. (38). 1892. **I**

WARNER, JAMES D., 199 Baltic St., Brooklyn, N. Y. (18). 1874. **A B**

Warner, Worcester R., 887 Case Ave., Cleveland, Ohio (33). 1888. **A B D**

Warren, Dr. Joseph W., Bryn Mawr Coll., Bryn Mawr, Pa. (31). 1886. **F**

Warren, Prof. S. Edward, Newton, Mass. (17). 1875. **A–I**

WATSON, PROF. WM., 107 Marlborough St., Boston, Mass. (12). 1884. **A**

Webb, Prof. J. Burkitt, Stevens Inst., Hoboken, N. J. (31). 1883. **D B A**

Weber, Prof. Henry A., Ohio State Univ., Columbus, Ohio (35). 1888. **F**

Webster, F. M., Wooster, Ohio (35). 1890. **F**

Webster, Prof. N. B., Vineland, N. J. (7). 1874. **B C E**

Weed, Clarence M., Durham, N. H. (38). 1890. **F**

Weld, Prof. Laenas G., State Univ. of Iowa, Iowa City, Iowa (41). 1895. **A**

WEST, Dr. CHARLES E., Brooklyn, N. Y. (1). 1895.

Wheeler, Orlando B., Office Mo. River Com., 1515 Lucas Place, St. Louis Mo. (24). 1882. **A D**

White, Prof. C. A., Le Droit Park, Washington, D. C. (17). 1875. **E F**

White, David, U. S. National Museum, Washington, D. C. (40). 1892. **E F**

White, Prof. H. C., Univ. of Georgia, Athens, Ga. (29). 1885. **C**

WHITE, PROF. I. C., Univ. of W. Va., Morgantown, W. Va. (25). 1882. **E**

Whiteaves, J. F., Geol. Survey, Ottawa, Ontario, Can. (31). 1887. **E F**

Whitfield, J. Edward, 406 Locust St., Philadelphia, Pa. (44). 1896. **C**

Whitfield, R. P., American Museum Natural History, 77th St. and 8th Avenue, New York, N. Y. (18). 1874. **E F H**

Whiting, Miss Sarah F., Wellesley College, Wellesley, Mass. (31). 1883. **B A**

Whitman, Prof. Frank P., Adelbert College, Cleveland, Ohio (33). 1885. **A B**

Wilbur, A. B., Middletown, N. Y. (23). 1874. **E**

Wiley, Prof. Harvey W., Dep't of Agric., Washington, D.C. (21). 1874. **C**

Williams, Benezette, 171 La Salle St., Chicago, Ill. (33). 1887. **D**

Williams, Charles H., M.D., 15 Arlington St., Boston, Mass. (22). 1874.

Williams, Prof. Edw. H., jr., 117 Church St., Bethlehem, Pa. (25). 1894. **E D**

Williams, Prof. Henry Shaler, Yale College, New Haven, Conn. (18). 1882. **E F**

Williams, Prof. Thomas A., Division of Agrostology, Dept. of Agric., Washington, D. C. (42). 1894. **G**

Willis, Bailey, U. S. Geol. Survey, Washington, D. C. (36). 1890.

Willson, Prof. Frederick N., Princeton, N. J. (33). 1887. **A D**

Willson, Robert W., Cambridge, Mass. (30). 1890. **B A**

Wilson, Joseph M., Room 1036, Drexel Building, Philadelphia, Pa. (33). 1886. **D**

Wilson, Robert N., Macleod, Alberta, Can. (42). 1895. **H**

Wilson, Thomas, U. S. Nat'l Museum, Washington, D. C. (36). 1888. **H**

Wilson, Prof. William Powell, Dept. of Biology, Univ. of Pa., Philadelphia, Pa. (38). 1889. **G**

Winchell, Horace V., 1306 S. E. 7th St., Minneapolis, Minn. (34). 1890. **E C**

Winchell, Prof. N. H., Univ. of Minnesota, Minneapolis, Minn. (19). 1874. **E H**

Wing, Henry H., 3 Reservoir Ave., Ithaca, N. Y. (38). 1890.

Winlock, Wm. C., Smithsonian Institution, Washington, D. C. (33). 1885. **A B**

Winslow, Arthur, care Mo. Kans. & Tex. Trust Co., Kansas City, Mo. (37). 1889. **E**

Winterhalter, A. G., Lt. U. S. N., care Navy Dept., Washington, D. C. (37). 1893. **A**

Withers, Prof. W. A., Agric. and Mechanical College, Raleigh, N. C. (33). 1891. **C**

Witthaus, Dr. R. A., 303 W. 77th St., New York, N. Y. (35). 1890.

Wolff, Dr. J. E., 15 Story St., Cambridge, Mass. (36). 1894. **E**

Wood, Prof. De Volson, Hoboken, N. J. (29). 1881.

Woodbury, C. J. H., Amer. Bell Telephone Co., 125 Milk St., Boston, Mass. (29). 1884. **D**

Woodman, Dr. Durand, 80 Beaver St., New York, N. Y. (41). 1896.

Woodrow, James, Pres. So. Carolina College, Columbia, S. C. (43). 1895. **E**

Woodward, Prof. Calvin M., 1761 Missouri Ave., St. Louis, Mo. (32). 1884. **D A I**

Woodward, R. S., Columbia Univ., New York, N. Y. (33). 1885. **A B D**

Wormley, T. G., Univ. of Pennsylvania, Philadelphia, Pa. (20). 1878.

Worthen, W. E., 63 Bleeker St., New York, N. Y. (36). 1888. **D**

Wrampelmeier, Theo. J., Room 17, Appraiser's Building, San Francisco, Cal. (34). 1887. **C**

Wright, Prof. Albert A., Oberlin College, Oberlin, Ohio (24). 1880. **E F**

Wright, Prof. Arthur W., Yale Coll., New Haven. Conn. (14). 1874. **A B**

Wright, Carroll D., LL.D., Dep't of Labor, Washington, D. C. (41). 1894. **I**

Wright, Rev. Geo. F., Oberlin College, Oberlin, Ohio (29). 1882. **E H**

Wright, Prof. Thos. W., Union College, Schenectady, N. Y. (36). 1889.

Würtele, Rev. Louis C., Acton Vale, P. Q., Can. (11). 1875. **E**

Youmans, Wm. Jay, M.D., Popular Science Monthly, 72 Fifth Ave., New York, N. Y. (28). 1889. **F C**

Young, A. V. E., Northwestern Univ., Evanston, Ill. (33). 1886. **C B**

Young, C. A., Prof. of Astronomy, Princeton Univ. Princeton, N. J. (18). 1874. **A B D**

Zalinski, E. L., U. S. A., care U. S. Legation, Tokio, Japan (36). 1891. **D**

Ziwet, Alexander, 44 Madison St., Ann Arbor, Mich. (38). 1890. **A**

[808 HONORARY FELLOWS AND FELLOWS.]

SUMMARY.—PATRONS, 2; CORRESPONDING MEMBERS, 1; MEMBERS, 991; HONORARY FELLOWS, 3; FELLOWS, 805.

DECEMBER 31, 1896, TOTAL NUMBER OF MEMBERS OF THE ASSOCIATION, 1802.

DECEASED MEMBERS.

A list of deceased members of the Association, so far as known, to the time of publishing the volume of Proceedings of the Springfield meeting, May 1896, is given in that volume. At the Buffalo meeting the Council directed the Permanent Secretary to omit the printing of the full list of deceased members in the annual volumes and to print only the additions to the list.

The Secretary requests information as to dates and places of birth and death of members when not given in the list.

Since the publication of the list in the Springfield volume, notices have been received of the deeease of the following members:

John G. Bourke, Washington, D. C. (33). Born in Philadelphia, Pa., in 1843. Died in Philadelphia, Pa., June 8, 1896.

Thomas T. Bouvé, Boston, Mass. (1.) Born in Boston, Mass., Jan. 14, 1815. Died in Hingham, Mass., June 3, 1896.

Stephen Bush, Waterford, N. Y. (19). Born in Nassau, N. Y., May 30, 1818. Died in Waterford, N. Y., July 15, 1896.

Oscar Craig, Rochester, N. Y. (41). Died Jan. —, 1894.

Charles O. Curtman, St. Louis, Mo. (39).

J. C. Foye, Chicago, Ill. (29). Died July 3, 1896.

G. Brown Goode, Washington, D. C. (22). Born in New Albany, Ind., Feb. 13, 1851. Died in Washington, D. C., Sept. 6, 1896.

Benjamin Apthorp Gould, Cambridge, Mass. (2). Born in Boston, Mass., Sept. 27, 1824. Died in Cambridge, Mass., Nov. 26, 1896.

Horatio Hale, Clinton, Ontario, Can. (30). Died Dec. 28, 1896.

Robert Hay, Junction City, Kan. (36). Born in Ashton-under-Lyne, Lancashire, Eng., May 19, 1835. Died in Junction City, Kan., Dec. 14, 1895.

Bela Hubbard, Detroit, Mich. (1). Died in June, 1896.

Charles McK. Leoser, New York, N. Y. (32). Died Feb. 23, 1896.

N. T. Lupton, Auburn, Ala. (17). Died June 10, 1893.

Tyler McWhorter, Aledo, Ill. (20). Born in Avoca, N. Y., Aug. 29, 1815. Died in Aledo, Ill., March 5, 1896.

Hubert A. Newton, New Haven, Conn. (6). Born in Sherburne, N. Y., March 19, 1830. Died in New Haven, Conn., Aug. 12, 1896.

George Dean Phippen, Salem, Mass. (18). Born in Salem, Mass., April 13, 1815. Died in Salem, Mass., Dec. 27, 1895.

Albert Nelson Prentiss, Ithaca, N. Y. (35). Born in Cazenovia, N. Y., May 22, 1836. Died in Ithaca, N. Y., Aug. 14, 1896.

Mark Samuel, New York, N. Y. (43).

Justus Mitchell Silliman, Easton, Pa. (19). Born in New Canaan, Conn. Jan. 25, 1842. Died in Easton, Pa., April 15, 1896.

Samuel L. Smedley, Philadelphia, Pa. (33). Died July 21, 1894.

Charles Speck, St. Louis, Mo. (27). Died in St. Louis, Mo., Oct. 25, 1896.

Charles Wachsmuth, Burlington, Iowa (30). Born in Hannover, Germany Sept. 13, 1829. Died in Burlington, Iowa, Feb. 7, 1896.

Josiah D. Whitney, Cambridge, Mass. (1). Born in Northampton, Mass., Nov. 23, 1819. Died in New London, N. H., Aug. 19, 1896.

John B. Woodward, Brooklyn, N. Y. (43). Died March 6, 1896.

(83)

ADDRESS

BY

EDWARD W. MORLEY,

THE RETIRING PRESIDENT OF THE ASSOCIATION.

A COMPLETED CHAPTER IN THE HISTORY OF THE ATOMIC THEORY.

THE great discovery of the law of gravitation was left reasonably complete by its author. The explanation of this fact is obvious. No other force of sensible magnitude complicates the action of gravitation; its law appeals to simple geometrical relations; and the facts had been well observed and reduced to order. Accordingly, by a few numerical comparisons of the hypothesis with the facts, Newton established the truth of his conjecture so that it has been generally accepted as a law of nature. The first suggestion of the theory was quickly followed by its final triumph.

Very different has been the history of the discovery which most chemists regard as next in importance to that of Newton. The discovery that matter consists of an aggregation of infinitesimal units or individuals was made by Dalton; but the first suggestion of this kind had been made at least twenty-two centuries before Dalton. Leucippus and Democritus were the earliest recorded believers in this doctrine; Epicurus adopted it; Lucretius expounded it in strains of noble eloquence. But all the early suggestions were quite barren and unfruitful for the advancement of science, for no one before the present century was in a position to make any verifiable hypothesis; and science grows by means of hypotheses so closely in touch with facts as to be verifiable. In later times, Leibnitz accepted the notion of a certain kind of atomic structure of matter; Newton accepted,

and reasoned soundly upon, a view which Dalton recognized as akin to his own. Kant seems to have adopted the contrary opinion, and to have believed that matter is infinitely divisible. But Bernouilli made the conjecture, which has since been verified, that a given volume of a gas consists of a very large number of very small discrete particles, which we now call molecules; and Higgins, an English chemist, a contemporary of Dalton, was the first to apply the notion of atoms to the explanation of chemical phenomena, although he did not think clearly in regard to the weight of atoms, and so formed no useful hypothesis. Accordingly, the net result of twenty-two centuries of thought on this subject was, to form a conception of a possible structure of matter, without imagining any way of establishing the truth or error of this conception, or even of gaining any evidence whatever in regard to it. But, if any are inclined to visit this failure with reproach, it is interesting to notice that the first man who was aware of the quantitative relations which are adapted to throw light on the matter did not fail to make the most full and complete use of this knowledge.

Dalton, and not the ancients, ought to be regarded as the discoverer of the atomic structure of matter, because he invented a hypothesis, involving such a structure, which was capable of being so compared with facts as to be proved or contradicted; because he actually began such a comparison of the hypothesis with the facts; and because all the evidence from facts, varied as it has since become, supports the hypothesis substantially in the form which he gave it. He who suggests that a certain benefit is desirable, or who conjectures that it is possible, shall not fail of due credit; but he who *confers* the benefit will receive the credit due the benefactor.

Since Dalton's discovery, much has been done to confirm and enlarge our knowledge of the atomic structure of matter. New evidence has been acquired in favor of it, because the theory has been ready to extend over whole realms of facts of a kind unknown to Dalton, to explain them, to facilitate their study; and also ready to predict facts, unknown till they were sought in consequence of the prediction, but found when they were sought.

The history of the atomic theory for ninety years would fall into several distinct chapters. One of these chapters, not the least interesting of them, would tell of a very large amount of

work, some of it of consummate accuracy, of which the object was to attain some knowledge of the nature or construction of atoms. Since the last meeting of our Association in this city, work has been accomplished which, if I rightly judge, has ended this particular chapter. That the chapter may at some future time be resumed is, of course, not absolutely impossible; but for the present it has come to a definite close. My own interest in the matter suggests, and the coincidence in time now mentioned perhaps justifies, my selection of this completed chapter in the history of the atomic theory as the subject of the address which our constitution requires of me this evening.

This chapter naturally concerns more intimately the members of the sections of Physics and Chemistry. To these I can hardly hope to say anything not already well known to them; but members of other sections may, perhaps, not be entirely uninterested in an account of the conclusions reached.

Dalton's theory was founded on three facts. These facts are often called Dalton's laws; one of them, because he discovered it, the others because he first recognized their important relations to chemical theory. One of these is the law of definite proportions: in any chemical compound, the ratio of the components is constant, is invariable, is definite. This truth had been recognized by others; it was finally established as a result of the discussion between Berthollet and Proust; a discussion well worth recalling for the dignified courtesy and simple love for truth shown by both the disputants. A second of these laws of Dalton is the law of equivalent proportions: if two elements, which combine with each other, combine also with a third, then the ratio in which they combine with each other (or a simple multiple of it) is also the ratio of the quantities of those which combine with the same quantity of the third. That this was true, at least in some cases, was known before Dalton. The third law is the law of multiple proportions: if two bodies combine in more than one ratio, those ratios are simple multiples of each other. This truth was discovered by Dalton.

These three laws are statements of *facts*. Careful and multiplied experiments have convinced us that, if these statements are not rigorously exact, their deviation from accuracy is less than the accidental errors of the best experiments used to test them.

Perhaps it is worth while to delay for a moment, in order to

state to what degree of precision such experiments have been brought. The degree of precision with which any supposed law can be verified depends on the skill of the investigator, on the instrumental equipment available, and on the conditions of the problem. Often the conditions of the problem impose very stringent limitations on the precision of our experiments. For instance, the truth known as Ohm's law has been verified, in the case of metallic conductors, to one part in a million millions; but in the case of liquid conductors, the conditions are such that the precision attainable so far has been only a millionth as much. Huyghens' law, relating to double refraction, has been verified to one part in half a million, and there seems to be no possibility of attaining any considerable increase in the precision of the observations. These are examples of the very highest degree of precision which has been secured in the verification of supposed laws of nature.

The precision which can be attained in chemical analysis, even of the most elaborate kind, is much less than in the cases just mentioned. The determination of atomic weights is the chemical process in which the highest degree of precision is demanded. If we denote the precision of such determinations by the words "good," "excellent," "admirable," "consummate," then we may fairly say that in a good series of determinations the average difference from the mean of all will be less than one thousandth part of the ratio sought; in an excellent series, less than one three-thousandth part; in an admirable series, less than one ten-thousandth part; and in a consummate series, less than one fifty-thousandth part.

Now the work of Stas was all admirable in precision, and much of it was consummate, and he made experiments expressly intended to verify the law of definite proportions. The average error in this series of experiments was not more than one part in thirty thousand; and his result was, that, if the composition of the compounds examined is not rigorously constant, the variations are too small to be detected. The law of equivalent proportions was verified with the same degree of precision: the accuracy of the law of multiple proportions has been thought to be deducible from the truth of the two other laws.

To some such degree of precision, then, Dalton's laws are the expression of facts. With these facts for a guide, and with no

theory founded on the facts and explaining the facts, all chemical computations could be made, and chemical formulæ could be established. And, if a theory should be devised, and accepted, and finally overthrown, these facts would remain, unchanged, for our perpetual guidance. Some of Dalton's contemporaries accepted the facts as a sufficient guide, and refused to burden them with the weight of the theory. Some were engrossed, for the time, in following out practical consequences of the facts; some distrusted conclusions supported by but a single line of evidence; some, perhaps, distrusted the capacities of the human mind. But the facts were accepted.

All scientific men, all sensible men, have a great respect for facts. Perhaps one cannot have too great a respect for facts; but his respect may be wrongly directed. Facts are often very interesting in themselves; they often have an important relation to human welfare; their discovery is often a great intellectual triumph: and we may regard them as the miser regards his gold, forgetting that the most precious use of facts is to help us to see beyond them. Facts are evidence; but we seek a verdict. Facts are a telescope; we desire enlargement of vision, further insight into nature. Facts are openings which we laboriously hew in the walls which shut us in; they cost enough to be valuable, but their real value is in that which they promise or disclose. Facts are a foundation for our building; the structure must rigorously respect the lines of the foundation; but it is a pity to believe that the basement walls are the chief beauty desired by the architect or owner. As Tyndall phrased it in a lecture at Manchester, "Out of experience in science, there always grows something finer than mere experience. Experience, in fact, only furnishes the soil for plants of higher growth."

In the present case the soil was fertile, the finer growth has been rapid and vigorous. Dalton inferred that chemical elements consist of very small units or individuals; that all the units or individuals of any given element are equal in weight; and that combination takes place by the grouping together of different units or individuals. This is Dalton's atomic theory.

In Dalton's time there was no fact opposed to this novel conclusion; but there was no second set of facts to support it. The progress of chemistry depended on making due use of Dalton's three laws, and they were quickly and generally accepted; but

whether the hypothetical chemical units or individuals actually exist or not, although a most interesting question, did not press for instant decision. Most chemists regarded with favor the idea of the actual existence of the chemical units or individuals. Dalton called them atoms, and perhaps the name brought misfortune; for many thought that the new theory was, that matter is made up of units or individuals which cannot be divided by any possible force. The word "atom," the word "indivisible," like the word "individual," properly mean that which is not divided in the phenomena considered. An absolutely indivisible atom, like an irresistible wave or an immovable rock, can be spoken of to puzzle children; but for adults, as Clifford said, "If there is anything which cannot be divided, we cannot know it, because we know nothing about possibilities and impossibilities; only about what has or has not taken place." I judge that many, probably most, chemists and physicists understand the word "atom" correctly; many others understand it to mean that which cannot be divided by any possible force, and so misunderstand it. For instance, the author of the "History of the Inductive Sciences" failed to understand the word as chemists and physicists understand it, and so supposed that he rejected the atomic theory. Many chemists would reject the theory that matter consists of very small units which *cannot* be divided: I suppose that very nearly all believe that matter is made up of small units which are not divided in any chemical or physical change yet observed. This is the atomic theory of Dalton.

A few years after Dalton had formed the atomic theory, and had obtained the first experimental evidence on a matter which had enlisted attention for more than two thousand years, Davy showed, by brilliant experiments, that certain bodies were compounds, although they had resisted all previous attempts to decompose them. Since the first use of electricity had so important results, men were ready to suspect that even supposed elements might ultimately prove to be compounds. It was therefore in a congenial soil that Prout's hypothesis took root. Trusting to experiments of not much accuracy, Prout suggested, in the year 1815, that probably the atomic weights of other elements were divisible, without remainder, by the atomic weight of hydrogen; or, in other words, that they are whole numbers, if the atomic weight of hydrogen be taken as unity.

The new suggestion was most attractive, for two reasons. On the one hand, the truth of the new suggestion would lead to a very great practical advantage. The labor of determining atomic weights would be immensely simplified and lessened if we could know beforehand that the numbers to be found were integers. And, on the other hand, the new suggestion, if approved, would promise a most interesting and valuable hint as to the nature of matter and the structure of atoms. If, for instance, the atoms of carbon and nitrogen and oxygen weigh precisely as much as twelve and fourteen and sixteen atoms of hydrogen, then it is a very plausible hypothesis that each of these atoms is really composed of the material of twelve and fourteen and sixteen atoms of hydrogen, compacted into a new atom. Davy had led many to suspect that perhaps some atoms might be compound, and the new suggestion looking in the same direction was received with favor by many, among whom were great discoverers, and great experimenters, and great teachers of chemistry. In England, where Davy and Prout both lived, Thomson had great influence. It was Thomson who, in the "Journal of Chemistry," of which he was the editor, first announced Dalton's discovery. Thomson wrote the history of chemistry. Thomson's "System of Chemistry" was thought worthy of translation into French at a time when French was the mother tongue of chemistry. And Thomson accepted Prout's hypothesis as probably true. But Turner made more accurate and more numerous determinations of atomic weights than any other English chemist; and he rejected Prout's hypothesis. Berzelius, the great Swedish chemist, whose determinations of the atomic weights of all the elements then known were regarded with so much admiration by all chemists, pronounced Prout's hypothesis a pure illusion. But Dumas, than whom none in France stood higher, whose opinion had great weight on account of the excellence of his many determinations of atomic weights, accepted Prout's hypothesis with a slight modification, and believed that his experiments had established its truth. Stas, the distinguished pupil of Dumas, began his work with a bias in favor of the hypothesis; but when his first series of admirable determinations of atomic weights was published, he pronounced the hypothesis a pure illusion, entirely irreconcilable with the numerical results of experiment. But Mallet, who has made several excellent determinations of atomic

weights, and Clarke, who has recomputed and reduced to order all the published determinations, declared themselves forced to give Prout's hypothesis a most respectful consideration. It is obvious, then, that ten years ago it was not finally settled whether the hypothesis was or was not true.

The hypothesis, then, has disappointed our hopes of any practical advantage in conducting to a knowledge of the exact value of any atomic weight. But nevertheless the hypothesis has not been neglected. As was said, if it is true, we may expect from it new insight into the nature of atoms. Accordingly, an immense amount of labor has been expended in attempting to determine whether the atomic weights of certain elements are or are not divisible without remainder by the atomic weight of hydrogen. Now since our last meeting in this city results have been attained which show that further effort in this direction is not justified by the hope of any theoretic advantage. The chapter has come to an end. Prout's hypothesis cannot be proved by experiment.

When we attempt to decide by experiment whether Prout's hypothesis is true, the nature of the problem, and the limitations of our present knowledge and of our available manipulative skill, impose three conditions to which we must conform.

In the first place, we can more readily test the correctness of Prout's hypothesis by determinations of the smaller atomic weights. The reason is obvious. All analytical work is affected with some accidental error or uncertainty. When Herschel wrote his admirable "Discourse on the Study of Natural Philosophy," he said that it was doubtful whether we could depend on the result of a chemical analysis as having an uncertainty less than one part in four hundred. Work of much greater accuracy has been done since this statement was made; but, for the moment, let us assume that, even now, the uncertainty of a determination of an atomic weight is a four-hundredth part. This uncertainty affects a large atomic weight much more unfavorably for our purpose than it affects a small atomic weight. For instance, Stas found the atomic weight of lead to be 206.91, if we take the atomic weight of oxygen as 16.00. The assumed uncertainty, one four-hundredth part of this, is 0.53; so that, on our assumption, the true value is somewhere between 206.38 and 207.44. These numbers differ more than a unit; no one has a right, on

this showing, to assert that the true value is the whole number 207.00, nor that it is not so.

But a small atomic weight may be much less unfavorably affected by the same proportionate uncertainty. For instance, recent determinations show that the atomic weight of oxygen is 15.88, when the atomic weight of hydrogen is taken as unity. The assumed uncertainty, one four-hundredth part of this, is 0.04; so that, on our assumption, the true value is between the limits 15.84 and 15.92. These numbers differ by only one twelfth of a unit; and both of them differ much from the nearest whole number, 16.00. It is, therefore, by determinations of small atomic weights that we may hope to decide the truth of Prout's hypothesis.

But among the smaller atomic weights, some, in the present state of our knowledge, can be more accurately determined than others. Accordingly, a second condition imposed on us by the limitations of our knowledge is, that we must determine, with what precision we can, those small atomic weights which admit of the maximum of precision. There are eight atomic weights upon which, with the experimental data now available, the decision of the matter may be fairly made to depend. These elements are lithium, carbon, nitrogen, oxygen, sodium, sulphur, chlorine, and potassium: the atomic weights are, in round numbers, 7, 12, 14, 16, 23, 32, 35.50, and 39. If numerous and careful experiments show that these atomic weights are whole numbers, Prout's hypothesis has a solid basis in fact; if seven are whole numbers and the other is 35.50, then Dumas's modified statement of the hypothesis has a solid basis in fact, for 35.50 is divisible without a remainder by *half* the atomic weight of hydrogen.

One more condition is imposed on us by the limitations of our knowledge and manipulative skill. Our experiments determine most atomic weights, not with reference to hydrogen, but with reference to oxygen. Experiment, for instance, does not determine directly that the atomic weight of lithium is seven times that of hydrogen, but that it is seven sixteenths that of oxygen. If the atomic weight of oxygen is uncertain, the atomic weights of the other seven elements with reference to hydrogen are all uncertain in the same proportion, although with reference to oxygen they are now determined with very small uncertainty.

Accordingly, the third condition imposed on us in attempting to learn the truth about Prout's hypothesis is, that the atomic weight of oxygen must be well determined.

It may be remarked that it would be a great gain, as all chemists will see, if several other atomic weights could be determined by direct comparison with hydrogen, provided the precision attainable was of the degree which I have called admirable, or even excellent. Now, methods have been devised by which the atomic weights of lithium, sodium, and potassium, as well as of several other metals, could be referred directly to hydrogen, by experiments which present no great difficulty, and which are capable of the required precision. Further, a method has been devised by which the atomic weight of chlorine can be determined with direct reference to hydrogen, by experiments capable of the required degree of precision, but involving considerable difficulty in manipulation. But until some such methods shall have been employed by some one, we must be content with the inferences which can be drawn from data of the kind now available, which depend on our knowledge of the atomic weight of oxygen as the corner stone of the system.

Our knowledge of the atomic weight of oxygen, ten years ago, depended largely on the experiments of Dumas. His results differed from the whole number 16.00 by one four-hundredth part; he himself judged that the uncertainty remaining might be one two-hundredth part. If we accept this estimate of uncertainty, we may say that he proved that the atomic weight of oxygen is included between the limits 15.88 and 16.04. No one could assert that the true number is, or that it is not, the whole number 16.00. A proportionate uncertainty, therefore, existed in the other seven atomic weights just mentioned. Accordingly, ten years ago we could not well discuss the question whether these atomic weights were divisible, without remainder, by the atomic weight of hydrogen.

The atomic weight of oxygen is, accordingly, doubly important for our purpose. The atomic weight is a small one, well adapted to aid in the solution; and, further, many other atomic weights, also well adapted to aid in the solution, depend on a prior knowledge of this constant. It is for this twofold reason that the work done since our last meeting at Buffalo is important and interesting. The members of this association have not failed to take

upon themselves a fair proportion of the considerable labor involved.

Since that time not less than ten or eleven independent determinations of the atomic weight of oxygen have been successfully concluded.

Cooke and Richards were the first to complete and publish their result; they used a new and ingenious process. Keiser was next; he employed a method for weighing hydrogen which he had independently invented (though it had been previously invented elsewhere), which is the best yet used. In both these series of experiments, the hydrogen was combined with oxygen by manipulation something like that of Dumas; but the improvement which permitted the direct weighing of the hydrogen made the essence of the process novel. Then Noyes devised a new method of weighing hydrogen directly, and a new manipulation for combining it with oxygen, and carried out the process in an apparatus having the advantage of great simplicity. Further, since our last meeting the Smithsonian Institution has published a work containing three series of determinations of the value in question,

In England, Lord Rayleigh used another novel method of combining oxygen and hydrogen, in which he weighed both elements in the form of gas. He also made two series of determinations of the ratio of the densities of the gases. Scott determined the ratio of the volumes of the gases which combine, in several series of experiments of great accuracy. Dittmar and Henderson rendered an important service by repeating, with many modifications, the experiments of Dumas; with the advantage which the later experimenter commonly has over the earlier, they were able to secure a much higher degree of precision, and to eliminate the sources of constant error which Dumas detected too late.

In France, Leduc repeated the experiments of Dumas, and also determined the ratio of the densities of the two gases.

In Denmark, Thomsen has applied a different process, in which the atomic weight of a given metal is compared with those of oxygen and of hydrogen successively.

We have, then, eleven series of determinations of the atomic weight of oxygen. One of these, for reasons which, so far, are chiefly matter of conjecture, differs much from the mean of all the

others. These other ten are concordant: they differ, on the average, only one part in twenty-two hundred from their mean, and the greatest difference from the mean is about one part in a thousand.

Since these experiments have been made by different processes, by different men, under varied conditions, and since the greatest difference from the mean of the whole is only one part in a thousand, it is probable that the mean of all differs from the truth by much less than one part in a thousand. The errors of our experiments are of two kinds, — accidental and systematic. If we shoot a hundred times at a mark, about half of our shots fall a little to the right, and about half a little to the left. These are accidental errors: accidental errors are lessened as our manipulation improves, and they but slightly affect our final mean. Systematic errors affect all our results in the same direction. Suppose we fire a hundred shots at a target one thousand yards distant, not examining the target till the shots are all fired. If, now, the sights of our rifle were set for five hundred yards, all our shots would strike too low. This is a systematic error: systematic errors diminish as our knowledge increases.

Accidental errors can be rendered harmless by taking the mean of numerous determinations made by the same method. But systematic errors must be detected and avoided. That they have been detected and avoided in any given case can never be definitely known; it can, at best, be presumed from the fact that experiments by different methods give the same result.

As to the atomic weight of oxygen, accidental errors have now been fairly eliminated, and we can make definite numerical statements on this point. If each of the ten sets of experiments were to be repeated with the same skill and knowledge, there is not one chance in a thousand that the new mean would differ from the present mean by as much as one part in sixteen thousand. Again, if ten new sets of experiments were to be made by new methods and new experimenters, there is not one chance in a thousand that the new mean would differ from the present mean by as much as one part in twenty-five hundred.

As to possible systematic errors, modesty in statement is incumbent on all scientific men. But we have now ten independent results, in which the difference from the mean is at most only one part in one thousand. We may then fairly assume that the

systematic error of the mean is less than one part in one thousand. Again, we have lately been able to take one step in advance, which throws needed light on precisely this point. It has been found possible to weigh some hydrogen, to weigh the requisite oxygen, and to weigh the water which they produce. If, now, there were some undetected systematic error in weighing either one of these three substances, occasioned, for instance, by some impurity remaining undetected in one of them, the sum of the weights of the hydrogen and oxygen would differ from the weight of the water produced. If a pound of sugar and a pound of water produce only one pound and three quarters of syrup, there was a quarter of a pound of sand in the sugar. Now it has, I think, been proved that, if the sum of the weights of the hydrogen and the oxygen is not precisely equal to the weight of the water produced, the difference is too small to be detected, and cannot be more than one part in twenty-five thousand. If there really were a difference of this amount, and, further, if this difference were due to an error at the precise point where it would be the most mischievous, it would render the atomic weight of oxygen uncertain by one part in about twenty-eight hundred.

Taking into account the presumption from the concordance of the results of different experimenters and the presumption from the agreement just mentioned, I think we are justified in assuming that the remaining systematic error is not more than one part in sixteen hundred, and that it probably is not more than one part in three thousand.

If this is a reasonable assumption, the net result of the experiments made in Denmark, France, Great Britain, and the United States is, that the atomic weight of oxygen is between 15.87 and 15.89, and that probably it is between 15.875 and 15.885. By no stretch can we imagine that the truth lies in the whole number 16.00, nor in the even fraction 15.50. We cannot sanely believe it to lie in the number 15.75, having modified Prout's hypothesis into the new statement that all atomic weights are divisible, without remainder, by one *quarter* of the atomic weight of hydrogen. It will be obvious that, if we are still resolved to accept some form of the attractive illusion, we must assume that the true divisor is as small as one eighth of the atomic weight of hydrogen, for the value $15\frac{7}{8}$ is included within the limits given.

Then there is one small and well determined atomic weight

which utterly refuses to support Prout's hypothesis, or any modification yet stated by believers in the hypothesis. Further, now that the atomic weight of oxygen is well established, we can compare, with hydrogen taken as unity, the seven other small and well determined atomic weights which have been mentioned.[1] We see that every value differs from an integer; for lithium, nitrogen, and potassium, the difference is about one part in two hundred thirty; for sodium, sulphur, and chlorine, about one part in one hundred eighty; for carbon and oxygen, about one part in one hundred thirty. On the average, these values, which are the best determined in chemistry, differ from whole numbers by about one part in one hundred eighty. There is less than one chance in a thousand that these numbers can possibly be so much in error. These are the numbers best fitted to test Prout's hypothesis; and their evidence against it is decisive.

It ought to be added, that the evidence against Prout's hypothesis seemed to many to be decisive, even without the knowledge of the atomic weight of oxygen which has recently been acquired. But the evidence can now be stated in a much more direct and simple manner; and it has gained in force, for to the seven fit instances at hand before there is added an eighth, which happens to be the most weighty of the whole.

In order to present the evidence against Prout's hypothesis when we lack an accurate knowledge of the atomic weight of oxygen, we have first to assume this value. We may, for one trial, assume that this value is the whole number 16.00, which is required by Prout's hypothesis, and see whether, on this assumption, the other seven atomic weights in question are very nearly such as the hypothesis requires.[2] But the average deviation from the numbers required by the hypothesis is one part in five hundred; and one deviation amounts to more than one part in three hundred. We may make another trial by assuming for oxygen, not the whole number 16.00, but that value which shall make the sum of all the deviations the least possible; and we may also take one quarter of the atomic weight of hydrogen as our divisor.[3]

[1] The values are as follows: Li = 6.97, C = 11.91, N = 13.94, O = 15.88, Na = 22.87, S = 31.83, Cl = 35.19, K = 38.84.

[2] The values on this assumption are as follows: Li = 7.02, C = 12.00, N = 14.04, O = 16.00 (assumed), Na = 23.07, S = 32.04, Cl = 35.46, K = 39.14.

[3] The values are as follows: Li = 7.00, C = 11.96, N = 13.99, O = 15.94, Na = 22.96, S = 31.96, Cl = 35.33, K = 39.00.

But the average deviations from the numbers required by the theory is, even in this case, one part in six hundred; and the atomic weight of that element for which the determinations of friends of the hypothesis agree with those of its opponents to one part in thirty-five hundred, is supposed, after all, to be in error by one part in five hundred. The atomic weight of oxygen, computed expressly to give every possible advantage to the hypothesis, differs from the whole number required by the theory by one part in two hundred fifty.

We read in our school-books of the bed of Procrustes, to which the tyrant fitted his compulsory lodgers; if they were too short, he stretched them on the rack, if they were too long, he lopped off the superfluous length. This fable was really a prophetic vision; the bed is Prout's hypothesis; our friends who admire it want to stretch the most unyielding quantities, and to lop off numbers which have been determined with the greatest precision. Either the experiments are in error by an amount which seems incredible, or the hypothesis is an illusion. If the supporters of the hypothesis would avoid the conclusion, they must supply better determinations, or they must detect real and tangible sources of error in those already made.

The hypothesis was most interesting and attractive: it promised, if sustained by experimental evidence, to give the means of such insight into the nature of matter and into the intimate structure of atoms that it was well worth all the attention which has been given to it. That it should fail of support, that its promises could not be kept, is a matter of regret; but it is time to recognize that our hopes are quite cut off. That other elements are composed of the same substance as hydrogen may or may not be true; but we have now no hope of proving it by determinations of atomic weight. It would not be difficult, perhaps, to modify Prout's hypothesis again and again, so as to bring it into some accord with the facts. We may imagine, if we will, that the observed numbers, if determined without error, would all be divisible by the eighth part of the atomic weight of hydrogen, or the ninth, or the tenth, or by some smaller fraction. But such a hypothesis is of no interest and of no utility, because it is incapable of proof or disproof by experiment. The reason is obvious. If we suppose that all atomic weights are divisible by one tenth of the atomic weight of hydrogen, then, in case the

theory is erroneous, the average deviation of the actual atomic weights from those required by the theory is only one fortieth of the unit. The man who supports a theory which has no physical basis would assert that all such ascertained deviations were due to errors of experiment. Others would reply that you cannot prove that a man is a good marksman by crowding the targets so near each other that not even his random shots can miss them all. But his backers might make so uncritical a claim.

No, Prout's hypothesis, if subdivided far enough, may be true for all which can be proved with the balance; but in such new form it is of no use and of no interest, for it cannot be proved so as to become a safe basis for further inference. In its present form, there is no root of truth in it.

So far, I have argued that Prout's hypothesis is not true as heretofore enunciated; and that, if some further modification of it is true, we cannot know it. This conclusion has been sustained by the evidence of the chemist's balance. A conclusion supported by a single kind of evidence may command the confidence of one who has been long familiar with the evidence, and who has become capable of weighing it. But, for others, the concurrence of evidence of different kinds rightly adds greatly to its cogency. In this case, there is such concurrent evidence. There is other proof that the atoms of some well studied elements are not *additive* structures. Let me briefly describe the nature of this evidence.

When certain elements are volatilized in a colorless gas-flame, or in the electric arc, their molecules are made to vibrate, so as to produce light. By the study of this light we can in time learn much of the nature of the vibrating system. The observed facts are gradually reducing to order; and one result is very striking. In the case of three closely similar elements before mentioned, lithium, sodium, and potassium, the complexity of vibration is precisely similar in all, and the numerical relations among the component vibrations are precisely similar in all. Therefore we are compelled to assume that the complexity of structure is the same in all, and that the relations of the component parts, and of the forces acting between them, are the same in all. To illustrate the nature of the argument: the complexity of vibration and the numerical relations among the component vibrations in the case of a large church bell are precisely similar to those in

the case of a bell only one third as large. Then, even without the direct evidence of other senses, we must presume that the two bells are similar structures, having similar parts, similarly related. We cannot believe that the larger bell is made of a small bell loaded with weights, nor of three small bells bound closely together. The larger and the smaller are of the same order. The larger is not made of more *parts* than the smaller; it is made of more *metal.* So with the atoms of these three elements; the larger are not made up by the addition of parts which preserve their identity and remain undivided. But all we know of chemical combination relates to structures which are made by the addition of parts which preserve their identity and remain undivided. Then Prout's hypothesis assumes an analogy which does not exist; and deductions from an imaginary analogy will themselves differ from the truth, much as fairy tales differ from history.

There are still other sources of evidence drawn from the specific heats of the elements; the evidence is of the same kind, and leads to the same conclusion, but I simply allude to it.

It seems to me, then, that the exact quantitative similarity of the spectra of these elements shows that they are not compounds one of another, subject to the great chemical law of the addition of undivided parts; and that also the magnitudes of the small and well determined atomic weights differ from the values hitherto suggested by applying the law of the addition of undivided parts, and differ by five, ten, and fifteen times the greatest experimental error we can reasonably assume.

So the citadel which defends the secret of the atom cannot be taken by way of Prout's hypothesis. We have carried on the assault for eighty years, and we are now satisfied that the way is blocked; we tried to breach, not a wall, but the solid mountain itself. We shall doubtless learn the structure of the atom, but we cannot learn it in the way we hoped. This chapter in our study of the nature of atoms has been fully ended.

If Prout's hypothesis cannot serve us, you will doubtless ask what other ways are open by which we may learn something of the structure of atoms. To answer is difficult; to answer adequately is impossible. Perhaps I may mention four lines in which it has been hoped by some that the desired advance could be made, and may indicate what it is reasonable to expect of each.

One of these indications of a possible source of knowledge as to the structure of atoms was suggested by certain chemical observations on some of the rare earths. My brief explanation will not do justice to the conception of the eminent chemist who investigated the phenomena. As I have said, the atom is something which, as a matter of fact, remains undivided in all chemical changes. Most atoms seem to resist every force which we can apply. But it is possible that the amount of resistance which they can offer may vary greatly: it may be that in the case of some elements the resistance is such that in some reactions the atoms remain undivided, and not in others. From the study of such cases, if there are such, we might expect much help. Now, in the case of the common and well studied elements, the occurrence of such cases has not been suspected; but some of the rarer elements, examined by a process which is frightfully laborious, have exhibited phenomena which suggest, as a hypothesis to be further studied, such a subdivision of atoms. But it is probable that we have mixtures of distinct elements which we do not yet know how to separate from each other by simple analytical processes. This chapter, we may fairly presume, will be valuable; but not because it will tell us anything new about the structure of atoms.

Certain spectroscopic phenomena have suggested that some elements may be decomposed by the action of a high temperature. For instance, it has been thought not impossible that, at the temperature of the electric arc, potassium compounds quite free from sodium should begin to show the spectrum of sodium, because at this temperature potassium is decomposed so as to produce sodium. This hypothesis has been carefully investigated; in part, by the accomplished physicist who is its author; in part, at his suggestion and invitation. It is found that, if years are given to the preparation of potassium compounds free from every trace of sodium, then it is impossible to obtain from them any phenomena suggesting a decomposition into sodium. Here, again, the new chapter, as far as it relates to the structure of the atom, is likely to be but short.

A third suggestion did not rest upon any observed chemical phenomena, but was a purely intellectual creation. This is the hypothesis that atoms are vortex rings in a frictionless fluid. It belongs to the mathematical physicist, rather than to the

chemist, to discuss this interesting suggestion. It may be said that it has seemed not impossible that the chemist should find a vortex ring capable of exerting certain chemical forces. But the fate of the hypothesis rested, not with the chemist, but with the mathematical physicist; and it has been found that the theory demands that the weight of a body composed of vortex atoms should increase with rise of temperature. It is scarcely possible that this can be the fact; if, then, the mathematical and physical reasoning involved is sound, it is scarcely possible that atoms consist of vortex rings. The probability is therefore but small, that we are to learn of the nature of atoms by means of this hypothesis.

Some spectroscopic and other optical phenomena seem to promise more light as to the structure of molecules and atoms, though the dawn is not yet. Thanks to the concave grating, we can determine the frequency of vibration of the light from any source with great accuracy. When the light is complex, we can determine, with great accuracy, the relative frequency of the component vibrations. In the cases which have been best studied, the observed frequencies have been reduced to rather simple numerical relations. From the study of these relations we may expect, in time, to determine the structure of the vibrating systems. But the way is long and difficult. Let us illustrate the nature of the method by means of a familiar example, namely, by the study of the structure of a sonorous vibrating system by means of the study of the sonorous vibrations produced by it.

Let us suppose a person deprived of the sense of hearing, but master of the whole mathematical theory of sound. Suppose, further, that he has an instrument which will do for sound what the spectroscope will do for light. With this instrument, let him observe the frequency and the relative intensity of the vibrations produced by certain musical instruments which we cause to vibrate for him, but withhold from his inspection. Let us, first, sound for him a single note on a piano. The vibrations produced are, as you know, somewhat complicated. Our imagined experimenter, with his instrument, observes vibrations whose frequencies are 100, 200, 300, 400, 500, and 600 in one second; and he also observes that the vibrations of 100 and 500 are of nearly equal intensity, that the vibrations 200, 300, and 400, have more than twice as great an intensity, and that

vibration 600 is very feeble. From these facts, if his attainments are sufficient, and his imagination sufficiently fertile, he can determine what system produced the sound. He imagines every possible vibrating system, — drum, cymbals, trumpet, flute, organ-pipe, harmonium-reed, violin-string, piano, harp, and more. Next, assuming each imagined system of such size or tune as to produce one hundred vibrations a second for its gravest tone, he computes what other vibrations will also be produced, and what the intensity of each. He finds, for instance, that a closed organ-pipe will give only the frequencies 100, 300, 500, but will not produce the other observed frequencies 200, 400, 600. Therefore, he concludes, the sound we produced for his study is not due to a closed organ-pipe. He finds, after many trials, that the observed frequencies and intensities could be produced by striking a stretched cord with a soft hammer, at a definite point near the end of the cord, so quickly that the cord and hammer remain in contact about the six-hundredth part of a second, and that the observed phenomena could not be produced by any other of the imagined vibrating systems. Then he concludes that the observed sound was probably produced by the stretched cord of a piano. He will have detected the true system, by first imagining every possible system, by computing the frequencies and corresponding intensities due to each hypothetical system, and by then comparing computation and observation.

For a second example, suppose we ring, for our imagined observer, a bell of a certain form, and that he notes the frequencies 200, 475, 845, and 1295 in one second; in which, also, he finds that the vibration 845 so predominates as to give its pitch to the compound tone. Our observer will not be able to refer this sound to any stretched cord, or to any organ-pipe or other wind instrument; for all these are limited to frequencies contained in the series 200, 400, 600, 800. A uniform metallic bar, suspended and struck like the triangle of an orchestra, will give frequencies not contained in this list, but they will be 200, 550, 1080, and 2670, instead of 200, 475, 845, and 1295. But if our observer has adequate powers, he will imagine a hemispherical bowl of suitable dimensions, and will, in imagination, add mass and rigidity in suitable places, until, in time, he will have devised a system whose computed vibrations agree in frequency, and in distribution of energy, with those of the invisible sounding body.

Then he would conclude that the observed sound was due to a bell of the form assumed in the successful computation.

This illustration sketches, imperfectly, I fear, the laborious method by which we may learn the structure of a vibrating system from a study of the vibrations produced by it. When we attempt to use this method in order to learn something about the structure of molecules and atoms, our powers of imagination and our mathematical skill are none too much. We know but little which can suggest plausible hypotheses. The facts which are to be explained have been but recently reduced to order. Accordingly, little has been actually accomplished. But there are some few examples of the use of this method of studying the structure of molecules and atoms.

In one such example, the structure imagined consisted of a system of concentric spherical shells, each connected with the adjacent shells by springs. This complicated structure admits of relatively simple computation, and was taken because it fairly well represents a rather simple imagined structure, for which, however, computation is difficult. But it was found that the results computed on this hypothesis gave little promise of agreement with facts.

This was a dynamical hypothesis; it suggested, not only vibrations, but the forces which were to produce them. A second example suggests certain possible motions, but not the forces which might produce the hypothetical motions; it is not dynamic, but kinetic.

As we know, many of the lines in the spectra of the elements are double. For instance, when a volatile compound of sodium is brought into a colorless gas-flame, this is colored yellow. When we examine this yellow flame with a spectroscope of sufficient power, we see that there are two frequencies, differing from each other by only one part in a thousand. Now it is probable that these two frequencies are due to the vibrations of one and the same body. There are many illustrations of the fact that a given body may perform two different vibrations whose frequencies differ but slightly. For instance, if we suspend a ball by means of a cord and let it oscillate as a pendulum, it is well known that a swing of six feet takes a little more time than a swing of three feet. Suppose, then, that we let our ball swing six feet north and south, and also three feet east and west at the same

time; the two motions may be combined so that the ball moves in an ellipse, — an ellipse whose longer axis is north and south. If the longer and the shorter swing had precisely the same frequency, the axis of the ellipse would continue in this direction; but since the frequencies differ, the ellipse slowly revolves. Conversely, from the revolution of an ellipse, we should infer a difference of frequency in the two component vibrations. So it is suggested that the two slightly different frequencies in the light sent out by ignited sodium are due to an elliptic motion in the molecule in which the elliptic orbit slowly revolves; this suggestion has not yet been carried so far as to specify any hypothetical cause for the revolution of the ellipse.

These two examples, both due to eminent English physicists, may serve to illustrate the method by which, if I am not mistaken, we are not unlikely to learn much as to the structure of molecules and atoms. We must not expect rapid progress. Even comparatively simple hypotheses may require, for their due examination, the invention of new mathematical methods. And useful hypotheses are rare: like the finding of buried treasures, they are not to be counted on. But, since Prout's hypothesis has rendered us its final service, new hypotheses must be devised, competent to guide us further on our way. Let us hope that, before this city again honors our association with its invitation to meet here, American chemists and physicists may have had some honorable share in such new advance.

SECTION A.

MATHEMATICS AND ASTRONOMY.

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Committee to Nominate Officers of Section.

The Vice-President and Secretary; and G. W. HOUGH, Evanston, Ill.; H. L. HODGKINS, Washington, D. C.; L. G. WELD, Iowa City, Iowa.

Press Secretary.

LAWRENCE LA FORGE, Alfred, N. Y.

Professor WILLIAM E. STORY, Vice-President elect, was unable to be present, and there was no Vice-Presidential Address before the Section.

On recommendation of the Section, the Council nominated Prof. ALEXANDER MACFARLANE of South Bethlehem, Pa., as Vice-President and Chairman of the Section, to fill the vacancy.. Prof. MACFARLANE was elected at the General Session on Tuesday morning.

PAPERS READ.

TUESDAY, AUGUST 25.

AN ANALOGUE TO DE MOIVRE'S THEOREM IN A PLANE POINT SYSTEM. By Prof. E. W. HYDE, University of Cincinnati, Ohio.

RATIONAL SCALENE TRIANGLE. By ARTEMAS MARTIN, U. S. Coast Survey, Washington, D. C. (To be published in the *Mathematical Magazine.*)

NEW ELEMENT OF THE VARIABLE R COMÆ, RESULTING FROM OBSERVATIONS IN JULY AND AUGUST, 1896. By HENRY M. PARKHURST, Brooklyn, N. Y.

PHOTOMETRIC OBSERVATIONS OF COLORED STARS. By HENRY M. PARKHURST, Brooklyn, N. Y.

MOTION OF THE GREAT RED SPOT AND EQUATORIAL BELT OF THE PLANET JUPITER FROM 1879 TO 1896. By Prof. G. W. HOUGH, Northwestern University, Evanston, Ill. (To be published in the *Monthly Notices* of the Royal Astronomical Society.)

ON THE DIRECT APPLICATION OF A RATIONAL DIFFERENTIAL EQUATION TO A SERIES OF POINTS WHOSE CO-ORDINATES REPRESENT OBSERVED PHYSICAL PROPERTIES. By Prof. ROBERT B. WARDER, Howard University, Washington, D. C. (Probably will be published in the *Journal of Physical Chemistry.*)

WEDNESDAY, AUGUST 26.

A PROPOSED FUNDAMENTAL INTEGRAL-TRANSCENDENT. By JAMES MCMAHON, Ithaca, N. Y. (To be published in *Annals of Mathematics*.)

ON THE LEVEL OF SUN-SPOTS. By Prof. EDWIN B. FROST, Hanover, N. H. (To be published in *The Astrophysical Journal*.)

SEDENIONS. By Prof. JAMES B. SHAW, Jacksonville, Ill. (Probably will be published in the *Bulletin of the American Mathematical Society*.)

ON THE DISTRIBUTION AND THE SECULAR VARIATION OF TERRESTRIAL MAGNETISM, No. IV.: ON THE COMPONENT FIELDS OF THE EARTH'S MAGNETISM. By Dr. L. A. BAUER, University of Chicago, Chicago, Ill. (To be published in *Terrestrial Magnetism*.)

DETERMINATION OF THE WEIGHTS OF OBSERVATIONS. By Prof. J. R. EASTMAN, U. S. Naval Observatory, Washington, D. C.

ON THE COMPOSITION OF SIMULTANEOUS AND SUCCESSIVE VECTORS. By Prof. A. MACFARLANE, South Bethlehem, Pa.

The Section adjourned Wednesday evening.

SECTION B.

PHYSICS.

OFFICERS OF SECTION B.

Vice-President, and Chairman of the Section.

CARL LEO MEES, Terre Haute, Ind.

Secretary.

FRANK P. WHITMAN, Cleveland, Ohio.

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Sectional Committee.

C. LEO MEES, Terre Haute, Ind., Vice-President, 1896.
FRANK P. WHITMAN, Cleveland, Ohio, Secretary, 1896.
W. LE CONTE STEVENS, Troy, N. Y., Vice-President, 1895.
ERNEST MERRITT, Ithaca, N. Y., Secretary, 1895.
BENJ. F. THOMAS, Columbus, O.
A. D. COLE, Granville, O.
W. A. ROGERS, Waterville, Me.

Member of Nominating Committee.

ERNEST MERRITT, Ithaca, N. Y.

Committee to Nominate Officers of Section.

The Vice-President and Secretary; and T. C. MENDENHALL, Worcester, Mass.; H. S. CARHART, Ann Arbor, Mich.; BROWN AYRES, New Orleans, La.

Press Secretary.

W. S. FRANKLIN, Ames, Iowa.

ADDRESS

BY

VICE-PRESIDENT

CARL LEO MEES,

CHAIRMAN OF SECTION B.

THE selection of a subject for presentation in an address such as I am called upon to deliver to-day, seems difficult. A large proportion of those who may listen to me to-day are workers in the same field which interests me and are familiar with the progress in the science of physics. It is, therefore, unlikely that I shall be able to present to you anything which may be new or startling; this I regret, for it seems that it requires something of this character to stimulate interest and research.

The aim of science in its most general sense is the discovery of truths. Its progress may be expressed by a curve approaching truth asymptotically, probably never in human experience approaching to its *complete* knowledge. So long as investigators find that they are working upon the steep part of the curve where it approaches truth rapidly, there is no lack of interest; this, however, seems to die out quickly when much labor and great patience are required to extend experimentally the curve now more slowly approaching complete knowledge, or straighten out some of its irregularities. As soon as a startlingly new or curious line of investigation is suggested every one pounces upon it and older problems are left far from completion. That we in America are especially inclined to this weakness in physical investigations I believe to be the case. Though investigations have been carried out by a number of American physicists, wellnigh to completion, involving years of painstaking labor, of which we may well be proud, yet I believe the tendency exists. It is this thought which

has led me to select for a brief review a line of study patiently carried on in Europe for a number of years, yet hardly touched upon by physicists in this country. In the last few years the studies in electrolysis and solution have been so fruitful that we can no longer afford to neglect them. It is also remarkable that these studies in electrolysis and molecular physics have been made almost exclusively by chemists, though of equal, if not greater, interest to the physicists; the problem should be attacked by them. To direct your attention then to some of the important work that should be undertaken by physicists is my object in reviewing, in the briefest possible manner, the progress of studies in electrolysis from their beginning to the present time.

Scarce one hundred years have passed since the first note of chemical action having been produced by electricity is to be found. About the middle of the eighteenth century Pater Beccari obtained metals from oxides between which electric sparks had passed. These results led to no further inquiry at the time, and were passed by almost unnoticed. Priestley, in 1778, critically studied the effect of the passage of the spark through air, noting the production of an acid gas. Cavendish continued these researches, explaining the action in the sense of the Phlogistic Theory of the day. Van Marum, extending Cavendish's investigations, decomposed ammonia, and through a careful study of the chemical changes brought about by the electric spark became converted from Stahl's Phlogiston Theory, stoutly maintained at the time, to Lavoisier's Oxygen Theory. Van Troest and Dieman, in 1739, gave the first unmistakable evidence of electrolytic action in decomposing water by means of the spark. The tendency towards an Electrical Theory of chemical action, fully developed later, becomes evident from the study of the literature of the day. These investigations were almost exclusively carried on by chemists; but little attention was given to the study of electricity, its nature and physical action; only the chemical results were of interest. The quantity of electricity at the command of the experimentalists at that time was so small that very definite results in electrolytic action could not be expected.

So far some progress had been made in the production and study of chemical effects resulting from electrical action; *the question of the possibility of the reversal of these effects, the production of electricity from the chemical action*, had not been

thought of. Volta was the first one to investigate *that* question. Galvani's discovery, given to the world in 1791 in a brochure of fifty-eight pages, gave a new stimulus to investigation, now taken in hand by physicists. The perusal of the little work is of great interest in the historical study of electricity. Galvani, as anatomist, looked for the source of electricity to the phenomena of life, believing it to be stored in the living cell. Volta, the trained physicist, sought for it in the material world and gave us the Contact Theory of electricity as distinguished from the Chemical Theory. These two theories have each been as stoutly maintained as controverted by the best experimentalists and thinkers of the century. Volta's great gift to the world was the Voltaic Battery, the study of which, together with the reversability of the action, has thrown a flood of light upon problems in molecular physics as well as upon chemical action, though the Contact Theory of electricity of Volta, accepted with modifications by many of the greatest physicists of this century, has undoubtedly been one of the strongest barriers to the progress of later and more satisfactory theories as to the seat of the electromotive force in the battery.

Passing over many important contributions from co-workers of Volta, laying a foundation for an understanding of the chemical effects of electricity, the most valuable work having perhaps been done by Ritter, we come to Nicholson and Carlisle, who on the 2d of May, 1800, opened the field for the study of electrolysis by the decomposition of water by means of the current from the Voltaic pile.

Volta seems to have avoided almost purposely the recognition of chemical action associated with the production and action of the current. It is remarkable, at any rate, that such action should have impressed itself most strongly upon all other experimentalists of that day, and scarcely be noticed by him.

From this time on we recognize for a considerable period two lines along which electrical problems have been studied. A long list of illustrious physicists from Ermann to Ohm studied the laws and physical effects of current electrical phenomena without questioning the somewhat unsatisfactory theory of Volta as to its source; another list, mostly chemists from Nicholson and Carlisle to Davy and Faraday, sought to determine the source of the current. To trace the development of modern theories historically would demand following both of these lines of research; time forbidding this, we

will consider but a few of the more important discoveries in each field as required.

Sir Humphry Davy succeeded in decomposing the fixed alkalies in a fused condition; the separation of the elements from their compounds was by him demonstrated in many experiments.

Before proceeding, however, it may be well to define a few terms used in discussing electrolysis and recall a few of its phenomena.

By electrolysis we mean the chemical changes which result from passing an electric current through a compound, usually in solution or in a state of fusion. The substance decomposed is called electrolyte. The battery terminals, or source of current, connected by the electrolyte, are called Electrodes, — the one bringing the current to the electrolyte the Anode, the one carrying it away the Kathode. As a result of the difference of potential of the electrodes, the materially different constituent parts of the electrolyte are impelled to move towards the electrodes; these wandering particles are called ions; those gathering about or moving towards the anode, anions; those about the kathode, kathions. The chemical changes are observable only at the electrodes. Taking as a simple case, ordinary hydrochloric acid, — a compound of hydrogen and chlorine dissolved in water, — the passage of the current causes chlorine to appear at the anode and hydrogen at the kathode. The hydrogen and chlorine, while in the solution finding their way to the electrodes, are ions; the chlorine-anion, the hydrogen-kathion. In many cases the action is not so simple. The electrolytic decomposition may be accompanied by chemical action occurring subsequent to or simultaneously with the appearance of the ions at the electrodes; the substance formed differing from the ions actually carried to the electrode. Changes of this character considerably complicate the problem, and make the correct interpretation of observed phenomena difficult. This general law may, however, be enunciated: An electrolyte under action of the current is split into two and only two parts, atoms or groups of atoms, no matter how complex its structure may be. These atoms or atomic groups thus separated are similar to the ones which exchange places in the ordinary chemical reactions. This early observed law led to the theory advocated by Berzelius, that all salts consisted of two atomic groups, one acid, the other basic, — erroneous, in that the chemical changes subsequent to the electrolytic action were not properly understood.

The wondering attention of early investigators had been directed to the curious phenomenon that the substances resulting from electrolysis appeared only at the electrodes and were not recognizable in the solution between the electrodes. The various theories propounded to explain this vied with one another in improbability. The difficulty of explaining this behavior satisfactorily seems to have led to the abandonment of the problem until, in 1805, Charles J. D. Freiher von Grothuss propounded a theory which gave a sufficiently reasonable explanation to be adhered to for fifty years, even quoted to-day in many text-books. Grothuss conceived that each molecule of a chemical compound acted like a conductor consisting of two parts capable of being separated; these molecules acted upon inductively by the charged electrodes, one group would become positively charged, the other negatively, the nature of the charge being determined by the character of the group, being acted upon by attractions and repulsions varying inversely as the square of the distance from the electrodes, the electrified *end* particles would be attracted to the electrodes; the remaining groups by separation and recombination would at once form a new series of molecules as before the action, ready for a repetition of the process; no freely charged groups thus remaining in the mass of the solution between the electrodes. This theory demands that the electrical forces between the plates vary inversely as the square of the distance; that when the force reaches a certain definite magnitude the groups will be separated; a further consequence is that when this critical force is attained all or a very great number of groups will be separated instantly, for if this attraction be equal to the force holding the groups together, the whole mass will be in unstable equilibrium, and any increase will cause complete separation of all groups.

Important experimental contributions followed one another rapidly, batteries were perfected, many physical actions of the electrical current were studied, the action of the current upon magnets was discovered, measuring instruments for quantitative work were invented, Ohm's law was enunciated, etc., so that when Michael Faraday, Sir Humphry Davy's man of all work and his successor at the Royal Institute, with matchless experimental genius and wonderful breadth of view, attacked the problem of electrochemical action, he had at his command the means for quantitative work in this field which enabled him to discover and formulate one

of the most important laws of electrolysis. Faraday's charming directness and clearness in the exposition of his work and results contrast refreshingly with the prolix, flowery, and mystifying style of his immediate predecessors; it at once stamped him a master of the subject treated. Faraday's original notes are well worth studying; they may be taken as models to-day by many who essay to record experimental results and conclusions. Confusion in terms and errors in inferences occurring in his work are well excusable; from our more extended and accurate knowledge, we are inclined to be unfairly critical. A review of Faraday's work in electrolysis alone would be interesting, for in it we may see foreshadowed many important points in the theories of to-day, though Faraday himself scarcely appreciated them.

The most important laws Faraday contributed to the behavior of electrolytes acted upon by a current are stated thus: —

The amount of chemical decomposition in electrolysis is proportional to the current and time of its action.

The mass of an ion liberated by a definite quantity of electricity is directly proportional to its chemical equivalent weight.

The quantity of electricity which is required to decompose a certain amount of a certain electrolyte is equal to the quantity which would be produced by recombining the separated ions in a battery.

The last law, clearly showing the reversibility of the process, at once makes the problem one capable of theoretical treatment from the standpoint of conservation of energy, and has brought most abundant fruit in later years. Faraday, in the main, accepted Grothuss' hypothesis, differing from him in the conception of the character and manner of action of the forces. Faraday showed experimentally, by measuring the change of potential between the electrodes, that Grothuss' conception of attracting and repelling forces, varying inversely as the square of the distance, was untenable; he (Faraday) assumed that through the action of the electrodes the chemical affinities of the combined ions were so changed or weakened that they acquired a greater attraction for the plates and their neighboring opposite ions; that decomposition and recombination occurred along the entire line. With Grothuss, he assumes that each liberated ion has a definite quantity of electricity belonging to it. This theory then demands that the action of the constituent parts of the electrolyte extend to considerable distance, and that the effect of the electrode is to modify or weaken the

chemical affinity between the groups so that decomposition results. Faraday leans to the opinion that chemical and electrical forces are identical, and in considering the reversibility of the process becomes an advocate of the chemical theory of the Voltaic cell.

Faraday, though somewhat confused in his nomenclature, brings out very clearly the relations between quantity of electricity and quantity of material separated, and electrical potential and chemical affinity, though at that time the concept of energy and work done, as a function of both potential and quantity of electricity, was not clearly established.

To review the work of Faraday in electro-chemistry alone, and the influence it had in the development of the more modern theories, would require more time than is allotted to us; the most important contribution on this subject has alone been mentioned.

In 1851 Williamson, from purely chemical evidence in the manner of the formation of some ethers, was led to believe that in solutions there is a constant interchange of atoms or groups of atoms between molecules, equivalent to dissociation and recombination, a view differing from those previously held, where this condition was supposed to be brought about by the action of the electric current. Williamson made no application of this conception to electrolysis.

Clausius, in 1857, applying the ideas growing out of the Kinetic Theory to solutions, points out the weaknesses of previously advocated theories; he shows that Grothuss' hypothesis, as well as its modifications by Daniell and Faraday, are not in accord with experimental results from accurate measurements. He shows that the hypothesis that the decomposition or tearing apart of the groups of atoms in the molecule by the electric forces, before transfer of electricity takes place, is untenable.

Clausius assumes that the molecules in the liquid stored with energy move with varying velocities; that collisions will occur which may cause the separation of the molecules into atomic groups for a short time; that during the period of separation these groups charged with opposite kinds of electricity peculiar to the groups will, under the influence of the electrode, be directed towards the electrodes in their path and thus become carriers of electricity; he ascribes to the liquid the conditions of dissociation due to fortuitous impacts always occurring, whether the solution be under the influence of external electrical forces or not; that the function of the electric forces is but directive, the effect being the disturbance of the internal kinetic equilibrium.

The principle of the conservation of energy, developed and applied in thermodynamic relations, influenced the manner of looking upon and interpreting electro-chemical processes. The most prominent names associated with the application of this great principle are Joule, Helmholtz, Willard Gibbs, Thomson, Boscha, Favre, and others. Much attention was now given to the problem, What is the cause of the electromotive force? The distribution of the energy in the electric circuit, including battery, electrolytic cell, and conductors, was investigated in the light of the energy concept, and attacked from the mathematical or dynamical side. Weaknesses in older theories were glaringly revealed if searched in the light of this principle. The dependence of the electromotive force upon the entropy term in the equations was shown, and its consequent variation with temperature.

The contributions of Willard Gibbs in this field are the most important, though scarcely appreciated; published in the Transactions of the Connecticut Academy, 1876–78, they were not very accessible and not generally known. This great work anticipated the many discoveries since made experimentally in a manner all but final in its comprehensiveness and completeness, opened out and suggested experimental investigations only partially undertaken and beginning to be carried out to-day. Why it was and is not more fully appreciated is probably due to its concentration; in the compass of some 300 pages and in 700 equations the entire subject of molecular dynamics is treated. The treatise was too rich to be grasped in its day; it is only beginning to be properly estimated twenty years after its first appearance.

About 1853 Hittorf quantitatively investigated, with great care, the change of concentration in solutions of electrolytes about the electrodes when a current passes. This phenomenon had been noticed and studied to some extent by Daniell and others, without, however, having been made use of in explaining the nature of electrolytic action. Hittorf's studies and conclusion bring us into the very midst of the modern views of electrolysis. Taking a simple case, let two electrodes of copper be placed vertically one above the other in a solution of copper sulphate, and pass a current through the cell making the lower plate the anode; no very noticeable change occurs other than that copper is dissolved at the anode and deposited at the kathode; if after the current has passed for a short time it is interrupted and the electrode short circuited through a galvanometer, a

current will for a short time flow in the cell from kathode to anode, that is, in a direction opposite to the one which has passed through in electrolyzing. The counter-electromotive force in this case cannot result from polarization at the electrodes, for no change has been brought about at their surfaces, such as a gas deposit in the case of decomposition in acidulated water with platinum electrodes. If the electrolyzing current be continued for some time it will be seen that the solution about the anode has become more concentrated and more dilute about the kathode; the total quantity of copper salt in the solution having, however, remained the same, the counter-electromotive force above referred to is due to this change in concentration.

Hittorf, from 1853 to 1859, examined in a most careful manner the behavior of many electrolytes, and by a series of analyses of the solutions determined this change of concentration due to the passage of the current. His patient labor has only within the last few years received proper recognition.

All theories which so far had survived the test conceived that the electricity was conveyed by a migration of particles, called ions by Faraday; whether these particles received their changes by contact with the electrodes or contained definite inherent quantities of electricity, the charges being the same for all ions, need not be considered at this time.

The first step toward the decisive establishment of the fact of the migration of the ions towards the plate would be an experimental measurement of the rate of migration; this was accomplished by Hittorf, and led to the enunciation of these laws: —

1. The change in concentration due to current is determined by the motion which the ions have in the unchanged solution.

2. The unlike ions must have different velocities to produce such change in concentration.

3. The numbers which express ionic velocities mean the relative distance through which the ions move between the salt molecules, or express their relative velocities in reference to the solution, the change in concentration being a function of the relative ionic velocities.

Hittorf's analyses enabled him to give their numerical values. A great many such have been made by him, Nernst, Loeb, and others; these results show that in dilute solutions the relative velocities of the ions are independent of the difference in potential between the electrodes (if the current be steady), and that they are only slightly affected by temperature.

Hittorf points out that a knowledge of the specific resistance of electrolytes should give valuable information in reference to the nature of electrolytic action. Horsford, Wiedemann, and Beez made such measurements; their methods were, however, imperfect; it remained for P. Kohlrausch to devise a method, using an alternating current, by means of which accurate results were obtained. Kohlrausch's work shows an amount of patience and experimental skill rarely found; his contributions will remain classical. In connection with Hittorf's work, Kohlrausch recognized that, according to Faraday's law, the conductivity should be represented by sums of the velocities of the ions, each carrying its electric charge. Thus, having from experimental data on conduction the sum of the velocities, and from Hittorf's migration constants based upon changes in concentration the ratio of the ionic velocities, the absolute velocities of the ions would be calculable. Inasmuch as the quantities he was to deal with were groups of atoms or molecules he determined at once to make the molecule his unit of quantity, and not mass alone. This expedient simplified the comparison of results and has been neglected by physicists. The comparison of results obtained by making the molecule the unit revealed at a glance relations between the physical behavior of different substances which would have been obscure if the mass had been chosen as unit. The selection of the most convenient proper unit is of great importance in the interpretation of results and the enunciation of physical laws.

Kohlrausch expressed the concentration in *gramme molecules* per unit volume of solution, the unit solution containing a number of grammes of the electrolyte equal to the number expressing the chemical equivalent on the hydrogen scale, in one litre of water. The measurements were then made upon solutions, the relative numbers of molecules in which were known. The ratio between the conductivity and the number of gramme molecules contained in the solution will then give molecular conductivities.

The results of such measurements show that as dilution increases there is an increase in molecular conductivity, that in very dilute solutions it approximates a limiting value. This increase of conductivity is considerable for bad conductors, less so for good conductors. The limiting value in dilute solutions of good conductors can be reached. In bad conductors, even at the extremest dilution accessible to measurement, the molecular conductivity is still far from the limiting value.

In general there is an increase of conductivity with increase of temperature, usually amounting to about two per cent per degree Centigrade.

The conductivity of equivalent quantities of neutral salts is of much the same order of magnitude, usually reaching the limiting value at a dilution of $\frac{1}{2000}$ gramme equivalent.

From Kohlrausch's numerical values and Hittorf's constants, the absolute velocity of a large number of ions was calculated. It appears from this, that the velocity of the ion in very dilute solutions depends only upon its own nature, and not upon the nature of the ions with which it may have been associated; thus the velocity of the chlorine ion was found to be the same when determined from solutions of KCl, $NaCl$, HCl, etc.

This important general law was also found, that the conductivities of neutral salts are additively composed of two values, one depending only upon the metal or positive ion, the other upon the acid radical or negative ion. According to this law the conductivity of a neutral salt can be calculated from a knowledge of the velocities of the ions independently, a test which has been applied in many cases with very satisfactory results when checked experimentally. For quite a number of compounds, however, the computed results were much too high, an abnormality to be discussed later. This law confirms the idea of independent migration of the ions.

Kohlrausch's numbers expressing velocities were checked by some exceedingly ingenious experiments by Oliver Lodge and Wetham; by a change in the color of the solution separated into two layers the migration of the ions could be directly measured. These results agree surprisingly well with Kohlrausch's, considering the widely different conditions and the difficulty of measurement.

About 1887 electro-chemistry entered into a new stage of progress; the central figure among those who were mainly active in bringing about this development was Swante Arrhenius, who, together with Ostwald and others, advanced a theory of electrolytic action, explaining very satisfactorily many well known phenomena. Arrhenius' theory involves the general idea contained in the theory of Clausius and Williamson, namely, that the solution contains the electrolyte dissociated into ions before the current is forced through it. Arrhenius adds that this dissociation is effected by solution or fusion, and that the ions contain charges of positive and negative electricity dependent upon their nature, but of equal quantity in

every ion. While in this state, that is, as ions, they move in an irregular manner between the molecules of the solvent and the undissociated molecules of the electrolyte, now attaching themselves to one another and again separating, upon the whole maintaining a condition of kinetic equilibrium. As soon as brought under the influence of the electrodes of different potential, they are impelled in definite directions, the anions towards the anode, the kathions towards the kathode.

The first work done by the current is the overcoming of the viscous resistances of the medium, not an inconsiderable amount; thus a portion of the energy of the current is frittered into heat.

At the electrodes another kind of work has to be done; either the charges have to be removed from the ions, changing them into the molecular condition, or new ions must be produced from the material of the electrode and the solvent, for kathions arriving the formation of anions, or for anions, kathions.

Undissociated molecules of the electrolyte take no part directly in electrolysis, except in so far as they may alter the viscous resistance of the solution.

The fact that molecular conductivity increases with dilution means that, as infinite dilution is approached, complete dissociation or ionization of the electrolyte is effected.

The ratio between molecular conductivity at greater concentration and infinite dilution expresses the degree of dissociation or ionization. The conductivity can always be expressed by the sum of the velocities of the ions into a coefficient expressive of the degree of dissociation: $C = A\ (u + v)$. In the limiting case $A = 1$, and the conductivity is measured by the sum of the ionic velocities; this is in accord with Kohlrausch's law.

One of the important points in this theory is that solution effects dissociation. Chemically pure substances, such as HCl in the liquid state, should not be electrolyzed; such is found to be the case. The curious fact that pure HCl and pure water alone are non-conductors, but become electrolytic conductors when mixed, is not rationally explained other than that dissociation results. Why it takes place, we do not know; that some change in the associated energy always takes place, we do know. In general, unless some chemical change occurs, solution is accompanied by refrigeration, except in the case of gases. It is probable, then, that some of the heat energy taken from the mixture is concerned in this dissociation.

In the case of fused substances heat may be a considerable factor in dissociation.

The question whence come the electric charges upon the ions is not solved. Whether they are inherent in the molecule and become free by ionization, or whether they result from the work done upon the molecules in dissociation, is not known. Some progress has been made towards the solution of the question by Ostwald, who succeeded in measuring the heat energy of ionization in a few cases. This problem is one that should be carefully studied.

An objection to the theory of the existence of free ions in a solution has been urged from the chemical side, namely, that the ions possess different properties from the atoms, or atomic groups. It seemed remarkable that a potassium ion should be capable of existing in water without combining with the oxygen, as would be the case in the ordinary atomic or molecular condition. If we consider, however, that the amount of associated energy in the two conditions is different, it is not difficult to imagine different properties. We know, for instance, that negatively charged zinc will not act on hydrochloric acid; that several elements exist in well known allotropic conditions, showing quite different properties. We explain this by different amounts of associated energy, which, in some cases, is quite measurable.

The difficulty of applying Ohm's law in the case of Grothuss' and Faraday's theories disappears in case of the dissociation theory; it rather becomes a necessary consequence of it.

Considering now a few phenomena not directly involved in electrolysis, evidence in favor of the dissociation theory may be found.

Substances form solutions when a homogeneous mixture results, the constituents of which cannot be separated by mechanical means, the proportion between the parts being continuously variable between certain limits, with a corresponding continuous variation in properties.

According to the state of aggregation of the dissolved substance before solution, energy changes usually become apparent, either in temperature changes, contraction of the volume, or the like, when solution is affected. As a rule, such energy changes occur in the same sense when solutions of different concentrations are mixed, until a point is reached, with very dilute solutions, when they no longer are observable. The substance in the solution is then very small in amount as compared with the solvent.

It is a well known fact that when solutions of different concentration are carefully superposed, the molecules of the dissolved substance pass from the more concentrated to the more dilute solution, until finally a uniform degree of concentration is attained, when a condition of kinetic equilibrium is maintained. This diffusion phenomenon in liquids is similar to that in gases, only it progresses much slower. In the case of gases the dynamics of the process is pretty well understood and satisfactorily explained by the kinetic theory, the mixture of the gases resulting from the projectile energy of the molecules. In the case of liquids it has been variously explained; in general, however, the molecular attraction between the solvent and the dissolved substance has been assumed as the cause. Van't Hoff has recently offered an explanation along the same kinetic lines so satisfactorily applied in gases. The force tending to produce diffusion must be measurable as a pressure, if it exist; if, then, the two solutions are separated by a semi-permeable membrane which will allow but one of the two constituents to pass, this pressure will become measurable upon the membrane. The production of such semi-permeable septa is a matter of very great difficulty, but has been accomplished to a very perfect degree for some substances. The general method of making such measurements is familiar to all physicists. Traube, Pfeffer, De Vries, Tammen, and Pringsheim, from 1867 to 1885, have succeeded in producing semi-permeable membranes of great perfection, and with improved apparatus have made many measurements of very satisfactory character. These results show that equi-molecular solutions of non-electrolytes show equal osmotic pressures. The osmotic pressure is directly proportional to concentration (expressed in gramme equivalents). The osmotic pressure is proportional to the absolute temperature.

The similarity of these laws to those of gaseous pressure is at once apparent. Van't Hoff further, upon the bases of absolute measurements and the applications of the ordinary equations for properties of gases, enunciates the law: That the molecules of the dissolved substance exert pressures in osmotic action, equal to the pressure which would be exerted by the same number of molecules in the gaseous state upon the sides of a containing vessel of the volume of the solution, the temperature remaining the same.

Osmotic pressure seems then to be merely a molecular kinetic effect. On this assumption thermodynamic considerations led to the same result as experiment.

The first two laws of osmotic pressure could be satisfactorily explained under the ordinary supposition of molecular attraction; the last two, however, are difficult to reconcile with any explanation other than the one that the pressure is due to molecular impact.

The osmotic pressure of electrolytes is considerably greater than that of non-electrolytes; in dilute solutions, however, they follow the same laws of variation. In quite a number of binary compounds it is just twice as great numerically as in the non-electrolytes. The behavior is as though the number of molecules contained in the electrolyte solution per gramme equivalent was greater than in non-electrolytes. If we imagine that solution has dissociated the molecule into two groups, the anomaly is easily explained. There is evidence here, independent of electrolytic behavior, that electrolytes are dissociated in solution.

Blagden, as early as 1788, recognized that salts in solution lowered the freezing point of water; his experiments were made mainly on sea water. He found that in very dilute solutions the lowering of the freezing point was very nearly proportionate to the amount of substance dissolved. Riedorf, Coppett, and Raoult carefully studied the subject, and found that the molecular depression of the freezing point was equal for salts of similar composition. For non-electrolytes, equimolecular solutions of different salts gave very nearly the same values, showing that the effect was purely a molecular one, independent of the nature of the substance.

The problem may be treated from the dynamical point of view upon this supposition. Knowing the osmotic pressure and imagining the change in state in the nature of a reversible cycle, the necessary energy changes are calculable. The depression of the freezing point calculated in this way for a number of substances gave values closely agreeing with experiment. The evidence that this effect is purely a molecular kinetic process is very strong.

Electrolytes cause a depression of the freezing point, experimentally determined, far greater than non-electrolytes; we have here another evidence of dissociation by solution.

The investigation of the effect of substances in solution upon vapor pressure and boiling point made by Berthelot, Beckmann, Raoult, Ciamician, Ostwald, and others, lead to precisely similar laws.

We may summarize these laws thus: —

Equi-molecular solutions of different substances made with equal masses of the same solvent show equal osmotic pressure, equal

sion, kathions will be projected upon the plate and made metallic, the electrode becoming positively charged and the solution negatively; similar to the action which takes place when a solid salt is brought into contact with a supersaturated solution where salt particles will be deposited.

The determination of the relative values of solution pressures is comparatively simple, the determination of their absolute values very difficult. In the case of mercury and a saturated solution of calcium chloride, the absolute value has been determined with considerable accuracy from the effect upon tension phenomena in the mercury surface, fully discussed by Lippman, Helmholtz, and Paschen. Ostwald and Planke obtained values by two methods based upon this action agreeing very well. With this value as a basis, others have been determined. Applying those values experimentally obtained, together with the ones for osmotic pressure, in calculating the electromotive force of a number of well known cells, an excellent agreement with experimentally determined values is found.

It will be impossible in this review to apply these theories to the various forms of batteries known, and to many phenomena of electrolysis which we have no space even to mention; the theories briefly reviewed have borne rich fruit in the more satisfactory explanation of electrolytic action. Many problems still remain to be attacked, while some have been but now appreciated.

The development of the solution and dissociation theories gives no explanation of the forces and conditions which cause solution or ionization, though some attempts have been made in this direction. Thus, J. J. Thomson has shown that, if the attraction between the ions in the molecule is due to electrical forces, it will be weakened if the molecules be immersed in a medium of high specific inductive capacity. Experimental evidence, in so far as it goes, shows that in liquids of high specific inductive capacity ionization is most complete. This is one of the problems to be systematically studied.

With the solution of the older problems new ones present themselves. This is the effect of any comprehensive good theory. Many new problems in molecular physics and electrolysis are suggested through Arrhenius', Van't Hoft's, and Nernst's theories. Their development and solution will not be one of chance, however, to be stumbled upon by daring or blind groping, but by intelligent, painstaking research. A bird's-eye view of the field is given us

through these theories; in filling in the detail and contours, the chance explorer must give way to the systematic investigator.

Until within the last three or four years, the systematic and careful amassing of experimental data for building up or verifying these theories was done by a few European workers, mostly chemists; since Willard Gibbs' theoretical work bearing upon this subject, scarcely a single addition of importance has come from American workers; in fact, it seems that much of the work done abroad is scarcely known to American physicists. It is to be regretted that in the history of the development of this branch of electrical science hardly an American name will appear.

There remains, however, much to be done, and contributions from this side will, I trust, be made.

Whether electrolytic action ever occurs in solids is a question which I do not believe has been definitely settled. If such action ever does take place, the theories just considered will have to be modified. Some very curious phenomena in glass, subjected to the action of the electric currents, have been noticed; the claim has been made that glass has actually been electrolyzed, though the evidence so far is not conclusive. The very interesting changes of conductivity with variation in temperature, exhaustively studied by Thomas Gray, indicate molecular changes which may be due to dissociation. The form of the equation for change in conductivity with temperature shows a maximum, with reversal, considerably below the fusing point. A similar peculiarity is noticed in alloys. The systematic study of this seems important.

Careful study of heat absorption when salts are dissolved should be made. Much work has been done in this direction. A careful examination and comparison of results, however, convinces one that the methods and manner of conducting the investigation must have been widely different, for the results vary in a most astonishing manner; at any rate, definite conclusions cannot be based upon them. If ionization requires energy, it is more than likely that some will be taken from the solution in the form of heat. In very dilute solutions dissociation of the electrolyte seems complete, while in concentrated solutions it is incomplete. A careful determination of the heat absorption per molecule, when the salt is dissolved in concentrated or dilute solutions, might give valuable results. The problem is very complicated, yet it should be attacked.

That gases can conduct electrolytically seems fairly certain. This field is scarcely entered, and may well be studied.

The peculiar behavior of charged plates under the influence of violet light seems likely to involve electrolytic action, and bear upon dissociation questions.

So multitudes of problems suggest themselves, the study of which may tend to crystallize the theories of dissociation and solution, so promising at this time, into more perfect form. It can scarcely be doubted that the remarkable connection evident when the phenomena of solution, modification of freezing and boiling point, osmotic pressure, optical rotation, chemical equilibrium and stability, metathetical reaction, thermal neutrality, electrical conductivity, and electrolysis are considered, taking the molecular equivalent mass as the unit, indicates a very near relationship of these processes. The power of Arrhenius' dissociation theory, Van't Hoff's solution theory, together with the conceptions of Hittorf, Clausius, Nernst, and Ostwald in explaining the dynamics of molecular action, is most promising. Whether more accurate and more plentiful quantitative studies of these so closely related phenomena will lead to closer concordance or greater divergence of the numerical values obtained, and thus strengthen or reveal weaknesses in the theories, must remain to be seen.

These theories, if fastened, will have a marked influence both upon the chemical and physical conceptions of the structure of complex molecules. They seem to demand essentially a condition of kinetic equilibrium between molecules and atoms; inter-atomic distances we shall have to consider greater than was our wont; atomic and molecular influences must extend to considerable distances. Geometrical static arrangement of atoms or groups of atoms seems incompatible with their behavior. The relation of atoms in the molecule seems rather to be orbital, permitting of ready rearrangement and readjustment by relatively slight disturbing causes, capable of returning to former relations promptly, involving various quantities of energy. All our inferences in reference to molecular magnitudes will have to be interpreted as effective merely, and not actual in the sense of space occupied.

The one central pillar upon and about which all physical science is erected to-day, the conservation of energy, stands unchanged, and, if possible, more clearly defined and strengthened than ever in these tests.

I repeat, may American physicists take up these problems and add their share to the development of these epoch-making theories.

PAPERS READ.

TUESDAY, AUGUST 25.

POLARIZATION AND INTERNAL RESISTANCE OF A GALVANIC CELL. By Prof. B. E. MOORE, South Bethlehem, Pa. (To be published in *Physical Review.*)

THE LEAD STORAGE CELL. BY Prof. B. E. MOORE, South Bethlehem, Pa. (To be published in *Physical Review.*)

A THEORY OF GALVANIC POLARIZATION. By Prof. W. S. FRANKLIN and L. B. SPINNEY, Ames, Iowa. (To be published in *Physical Review.*)

ON THE COUNTER ELECTROMOTIVE FORCE OF THE ELECTRIC ARC. By Prof. W. S. FRANKLIN, Ames, Iowa.

ON THE ELEMENT OF DIFFRACTION IN FRESNEL'S EXPERIMENTS WITH TWO MIRRORS AND WITH THE BI-PRISM. By Dr. ERNEST R. VON NARDROFF, Brooklyn, N. Y.

SEGMENTAL VIBRATIONS IN ALUMINUM VIOLINS. By Dr. ALFRED SPRINGER, Cincinnati, Ohio.

PRELIMINARY NOTE ON A PROPOSED NEW STANDARD OF LIGHT. By CLAYTON H. SHARP, Cornell University, Ithaca, N. Y. (To be published in *Transactions Amer. Assoc. of Electrical Engineers*, Vol. XIII., No. 4, p. 200.)

A PHOTOGRAPHIC STUDY OF THE RÖNTGEN RAYS. By Prof. W. A. ROGERS, Colby University, Waterville, Me.

NOTE ON THE DURATION OF THE X-RAY DISCHARGE IN CROOKES' TUBES. By DR. BENJAMIN F. THOMAS, State University, Columbus, Ohio. (To be published in *Electrical World* and in *Electrical Engineer.*)

WEDNESDAY, AUGUST 26.

PRELIMINARY COMMUNICATION CONCERNING THE ANOMALOUS DISPERSION OF QUARTZ FOR INFRA-RED RAYS OF GREAT WAVE LENGTH. By Prof. ERNEST F. NICHOLS, Hamilton, N. Y. (To be published in *Physical Review.*)

AN EXPERIMENTAL STUDY OF THE CHARGING AND DISCHARGING OF CONDENSERS. By Dr. F. E. MILLIS, Appleton, Wis. (To be published in *Physical Review.*)

NOTES ON CERTAIN PHYSICAL DIFFICULTIES IN THE CONSTRUCTION OF MODERN LARGE GUNS. By Prof. W. LECONTE STEVENS, Rensselaer Polytechnic Institute, Troy, N. Y.

ON THE PHOTOGRAPHIC TRACE OF THE CURVES DESCRIBED BY THE GYROSCOPIC PENDULUM. By Prof. ERNEST MERRITT, Ithaca, N. Y. (To be published in *Physical Review.*)

ON THE DISTRIBUTION OF HIGH FREQUENCY ALTERNATING CURRENTS THROUGHOUT THE CROSS-SECTION OF A WIRE. By Prof. ERNEST MERRITT, Ithaca, N. Y. (To be published in *Physical Review.*)

ON THE COMPACTNESS OF A BEAM OF LIGHT. By ERNEST R. VON NARDROFF, Brooklyn, N. Y.

SOME POINTS IN THE MECHANICAL CONCEPTION OF THE ELECTRO-MAGNETIC FIELD. By Prof. W. S. FRANKLIN, Ames, Iowa. (To be published in *Elements of Physics,* Vol. II., by E. L. Nichols and W. S. Franklin.)

MECHANICAL MODELS OF THE ELECTRIC CIRCUIT. By Prof. BROWN AYRES, Tulane University, New Orleans, La.

A NEW GRAPHICAL METHOD FOR CONSTRUCTING THE CLOCK DIAGRAM OF THE ALTERNATING CURRENT IN A CIRCUIT OF TWO PARALLEL BRANCHES CONTAINING OHMIC AND INDUCTIVE RESISTANCES AND CAPACITY, UNDER THE ACTION OF A CONSTANT HARMONIC ELECTROMOTIVE FORCE, IN CASE THE FREQUENCY IS VARIABLE. By Prof. HENRY T. EDDY, University of Minnesota, Minneapolis, Minn.

DESCRIPTION AND EXHIBITION OF A CONVENIENT FORM OF THE "INTERFERENTIAL COMPARER," AND OF AN INTERFERENTIAL CALIPER ATTACHMENT FOR USE IN PHYSICAL LABORATORIES. By Prof. W. A. ROGERS, Colby University, Waterville, Me.

DESCRIPTION AND EXHIBITION OF A BENCH COMPARATOR FOR GENERAL USE IN PHYSICAL LABORATORIES. By Prof. W. A. ROGERS, Colby University, Waterville, Me.

THURSDAY, AUGUST 27.

ON THE RULE FOR THE DYNAMO AND MOTOR. By Prof. ALEXANDER MACFARLANE, South Bethlehem, Pa.

DESCRIPTION AND EXHIBITION OF A PORTABLE APPARATUS FOR RECORDING CURVES OF ALTERNATING CURRENTS AND ELECTROMOTIVE FORCE. By H. J. HOTCHKISS, Cornell University, Ithaca, N. Y. (To be published in *Physical Review.*)

EXPERIMENTAL DETERMINATION OF THE RELATIVE AMOUNTS OF WORK DONE IN CHANGING THE LENGTHS OF TWO METAL BARS UNDER THE SAME THERMAL CONDITIONS, BY AN ENVELOPE OF HEATED AIR, AND BY PURE RADIATIONS IN A VACUUM. By Prof. W. A. ROGERS, Colby University, Waterville, Me.

AN EXPERIMENTAL METHOD OF FINDING THE VALUE OF A UNIT OF FORCE IN ANY SYSTEM WHATEVER. By Prof. W. A. ROGERS, Colby University, Waterville, Me.

A NEW ALTERNATING-CURRENT CURVE-TRACER. By Prof. EDWARD B. ROSA, Wesleyan University, Middletown, Conn.

VISIBLE ELECTRIC WAVES. By Prof. B. E. MOORE, South Bethlehem, Pa. (To be published in *Physical Review.*)

ELECTRICAL WAVES IN LONG PARALLEL WIRES. By Prof. A. D. COLE, Denison University, Granville, Ohio. (To be published in *Bulletin of the Scientific Laboratories of Denison University;* also by abstract in *Electrical World.*)

THE INFLUENCE OF A STATIC CHARGE OF ELECTRICITY ON THE SURFACE TENSION OF WATER. By Dr. EDWARD L. NICHOLS and JOHN ANSON CLARK, Cornell University, Ithaca, N. Y. (To be published in *Physical Review.*)

DETERMINATION OF THE SPECIFIC HEATS OF NITROGEN BY ADIABATIC EXPANSION. By Prof. W. S. FRANKLIN and L. B. SPINNEY, Ames, Iowa.

THE ANALYSIS OF VOWEL SOUNDS, BY MEANS OF THE SYMPATHETIC VIBRATIONS OF A RIGID BODY. By L. B. SPINNEY, Ames, Iowa. (To be published in *Physical Review.*)

POLAR AND INTERPOLAR EFFECTS OF THE GALVANIC CURRENT ON LIVING ANIMAL TISSUES. By Dr. C. P. HART, Wyoming, Ohio. (To be published in *Bulletin de la Société Française d'Electrothérapie,* Paris.)

NOTE ON THE EFFECT OF ODD HARMONICS UPON THE VIRTUAL VALUES OF PERIODICALLY VARYING QUANTITIES. By Dr. FREDERICK BEDELL, Cornell University, Ithaca, N. Y., and Dr. JAMES E. BOYD, Ohio State University, Columbus, Ohio.

The Section adjourned Thursday evening, August 27

SECTION C.

CHEMISTRY.

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ADDRESS

BY

VICE-PRESIDENT

WILLIAM A. NOYES,

CHAIRMAN OF SECTION C.

THE ACHIEVEMENTS OF PHYSICAL CHEMISTRY.

"PHYSICAL chemistry is the chemistry of the future." These words, quoted from an address by Professor Du Bois-Reymond, were used by Ostwald ten years ago in the introduction to the first number of the Zeitschrift für physikalische Chemie. In using these words Du Bois-Reymond looked forward to a time when it shall be possible to give a mathematical expression to all forms of chemical knowledge. The picture in his mind seems to have been that of a sort of astronomy of the atoms, in which the motions and forces within the molecules shall be known very much as are the motions and forces within the planetary system.

So far as any practical realization is concerned, the thought is still only a poetic fancy, and whatever progress, if any, may have been made, comes to us from organic rather than from physical chemistry. Indeed it seems to have become the fashion on the part of several leaders in physical chemistry to speak slightingly of the atomic and molecular theories. Their thought appears to be that it would be better to confine ourselves to the purely empirical and mathematical concept of the atom and molecule and leave the idea of particles which have an actual independent existence entirely in abeyance. It would doubtless be possible to give such definitions of atom and molecule as shall include only the results of our actual empirical knowledge and mathematical deductions therefrom. Such definitions would stand on a basis which is incontrovertible, and it is inconceivable that even the overthrow of the atomic theory, or any knowledge which may be gained in the future as to the nature of matter, could change them.

That such definitions possess great value is certain; and that it is very important to distinguish sharply between our positive knowledge and speculations and theories based on that knowledge, every one will admit; but, after all, unless we join that school of philosophy which teaches that there is no real existence outside of our own minds, there is some reality at the basis of and behind all the phenomena which we investigate. And it is the province of science to find out the truth about every real existence of which we can secure any tangible evidence. Our knowledge of atoms and molecules as actually existing particles is, doubtless, a purely speculative deduction from a multitude of diverse phenomena and yet the mental picture connected with the concept has been, and still continues to be, of very great value in the development of our science. These mental pictures are vague and in many respects incomplete, it is true, and they doubtless do not correspond closely to the real existences for which they are, at present, our best expression; but, to one familiar with the very practical results which have been obtained in the domain of structural chemistry, it is difficult to conceive how such results would have been possible without their use.

While physical chemistry has made little or no apparent progress toward the goal marked out by Du Bois-Reymond, its practical achievements during the last ten or fifteen years have been very considerable and it is to these practical achievements that I wish to turn our attention.

Whenever the subject of physical chemistry is mentioned our thoughts naturally turn to the subject of solutions. Not that physical chemistry has to do only or chiefly with solutions, for, as I understand it, physical chemistry has to do with all of those physical properties of matter which can only be understood by taking into consideration at the same time its composition; but rather because some of the most valuable results of physico-chemical researches have been in this field and because diversity of views has made this the chief recent battle-ground in chemistry.

Up to about eleven years ago our knowledge of solutions was almost entirely of an empirical character. No great generalization similar to those which had long been known for gases had been discovered. In 1885 J. H van't Hoff[1] proposed his theory of osmotic pressure. The empirical basis for this theory lay in the experiments of many different workers, some of them made many

years before. Studies in osmose date from the early years of this century and, indeed, some experiments were made more than a century ago. It was not, however, till 1867 that the discovery of true semi-permeable membranes was made. In that year M. Traube[2] showed that membranes may be prepared which will readily allow the passage of water but which are totally impervious to certain substances in solution. Ten years later W. Pfeffer[3] conceived the idea of preparing such membranes in the interior of a solid partition. By exposing a cup of porous porcelain to the action of a solution of copper sulphate on one side and of potassium ferrocyanide on the other, a precipitate is formed within the mass of the porcelain which is permeable to water but which is impervious to the passage of sugar and of many other substances. With such cells the osmotic pressure was measured and was found to be surprisingly great. For a one and a half per cent solution of saltpeter it is more than three atmospheres; for sea water it would be about twenty atmospheres. Pfeffer's experiments were made with reference to their bearing on the action of organic cells and on other physiological questions and it was eight years later before their extraordinary theoretical importance was pointed out by van't Hoff.

A careful study of the experimental data given by Pfeffer and others leads to the following conclusions:

First, the osmotic pressure is directly proportional to the concentration of the solution.

Second, the osmotic pressure is directly proportional to the absolute temperature. In establishing this law the experiments of Soret[4] are of especial interest. He subjected a solution of copper sulphate, contained in a vertical tube, to a temperature of 80° near the top and of 20° at the bottom. Under these circumstances the concentration increases below and diminishes above. After equilibrium was established it was found that the per cent of copper sulphate in the two parts of the solution was inversely as the absolute temperature. The analogy with what would take place in a gas under the same conditions is clear.

Third, solutions which are isotonic at a given temperature contain in unit volume the same number of molecules of the dissolved substance. Another statement of the same law, which gives it also a quantitative expression, is, that the osmotic pressure of a solution is the same as though the dissolved substance existed as

a gas within the same space. The osmotic pressure of a one per cent solution of sugar may be calculated by the same formula* which we should use to calculate the pressure exerted by one gram of a gaseous body having a molecular weight of 342 and contained in a volume of 100.6 cubic centimeters.

Every one recognizes, of course, that the laws which have been given for osmotic pressure are identical with the laws of Boyle, of Charles and of Avogadro for gases. Van't Hoff pointed out this analogy very clearly but he did not give any clear explanation of what he considered as the real cause of the phenomena of osmose. He spoke, from the purely empirical side, of the attraction which the solution exerts for pure water.[5] Ostwald in his Lehrbuch[6] is even more careful. He speaks of the cell as conducting itself as though there is within it a partial vacuum for water. These expressions are very similar to those of the older text-books which speak of the expansion of gases as due to the repulsion of their particles for each other, and appear to me equally misleading and unsatisfactory. In a later paper,[7] in reply to a criticism by Lothar Meyer,[8] van't Hoff gives a clearer explanation in terms of the kinetic theory.

If we have a gas in a confined space and introduce into it a small amount of some volatile liquid, the vapor of the liquid will rise and fill the space very nearly as though the gas were not present, and when equilibrium is reached the pressure will equal the original pressure of the gas plus the vapor pressure of the liquid. The explanation is that the pressure exerted on the surface of the liquid by the gas is not that of continuous matter, but is due to the bombardment of its surface by particles of discontinuous matter. The particles of the liquid find ample opportunity, therefore, to rise between the particles of the gas.

Let us take a second case, which has, however, as far I am aware, never been realized. Suppose a vessel having a wall impervious to the molecules of one gas but pervious to those of a second. If such a vessel, containing the first gas, is placed in an atmosphere of the second, the molecules of the latter will pass the

*$P = \frac{760 \times T.}{342 \times 0.045 \times 0.1006 \times 273}$

In this formula,

T = Absolute temperature.

342 = Molecular weight of cane sugar.

0.045 = One-half the weight of a liter of hydrogen.

0.1006 = Volume in liters of 100 grams of the solution

walls and enter the space occupied by the first, exactly as the molecules of the volatile liquid rise among the molecules of the gas above and equilibrium will be established only when the pressure exerted by the second gas is equal within and without. The pressure within the vessel will then exceed that on the outside by exactly the pressure exerted by the gas whose molecules cannot pass the wall.

The case with osmotic pressure is very similar to that last mentioned. Here we have a semi-permeable wall actually realized. For instance, we may have a wall which will allow water to pass freely but which is impervious to the molecules of sugar. If pure water be on one side of such a wall and a solution of sugar on the other, equilibrium can exist only when the pressure due to the water alone is equal on both sides; for the molecules of sugar, because of their discontinuous character, can exert no influence to cause the molecules of water to pass one way or the other, exactly as a gas can exert no permanent effect to prevent the vapor of a liquid from passing upward into it. In the end, therefore, the pressure on the side of the solution must exceed that on the side of the pure solvent by the amount of pressure due to the kinetic energy of the molecules of the dissolved substance. If we further suppose that this energy is the same in the liquid as in the gaseous state, and the laws of osmotic pressure give us every reason to believe that it is, the explanation is complete.

This explanation gives us a conception of liquids as very closely related to gases in many of their properties, the main difference being that, in the liquid, the molecule does not possess enough kinetic energy to separate it from the mass of neighboring molecules, although its motion within the confined space is very similar to that of the molecule of a gas.

But it is not only, nor, indeed, mainly in his study of the phenomena of osmose that van't Hoff has rendered the greatest service. Very few perfect semi-permeable walls are known, and osmotic pressures are very difficult to measure directly, so that, if we were dependent on direct measurements, the theory would be of scarcely more than theoretical interest. Van't Hoff pointed out, however, that the concentration of a solution by the removal of the solvent, whether effected by a piston composed of a semipermeable wall, by the evaporation of the solvent, or by the separation of crystals of the pure solvent by freezing, is, in each

case a reversible process analogous to the compression of a gas, and that, as with all other reversible processes, it is subject to the second law of thermo-dynamics. This made it possible to connect the lowering of the vapor pressure and the depression of the freezing point of solutions directly with their osmotic pressure. This has given an indirect determination of the osmotic pressure in thousands of different cases. As a practical result we have now at our disposal a large number of methods for the determination of the molecular weights of solid and liquid bodies.

The work of Raoult[9] in this field deserves especial mention, because he developed several methods of determining molecular weights from an empirical standpoint, before the theoretical development of the subject had been given by van't Hoff. Raoult's[7] work attracted the attention of Victor Meyer, who made use of his methods in the study of certain stereomeric bodies upon which he was at work. And it is in connection with stereoisomerism that the new methods of determining molecular weights have, perhaps, been of the greatest practical value in the development of chemical science; for, without the positive proof that the bodies studied are metameric and not polymeric, the foundation for the belief that they are stereomeric would be comparatively weak.

It is probably through articles published by Victor Meyer[10] and Auwers[11] that cryoscopic methods for the determination of molecular weights were first brought to the attention of a wide circle of chemists. Since then a large number of workers have busied themselves with the subject, partly in the development of suitable forms of apparatus and methods of manipulation, partly in the study of the scope and degree of accuracy of the laws and of exceptions to them. The most important of the methods developed are those dependent on the lowering of the freezing point of solutions,[12] on the raising of the boiling point,[13] on the lowering of the vapor pressure,[14] on the determination of isotonic solutions by vegetable membranes[15] and by blood corpuscles, and on the lessening of the solubility of ether in water or of phenol in water by the addition of substances soluble in ether or phenol but not in water. In the last case the determination is either direct in the case of phenol, or by the rise of the freezing point of the water[16] owing to the withdrawal of ether from it.

As was to be expected, the laws of osmotic pressure are sub-

ject to numerous exceptions, or rather modifications, for, strictly speaking, no true law of nature is ever subject to an exception. That which, by a figure of speech, we call an exception, is really a modification due to the simultaneous application of some other law. The modifications in this case are very similar to the modifications of Avogadro's law which retarded its acceptance for nearly a half century. Vapor densities are abnormally high on account of the associative tendency of molecules as in the case of acetic acid, or when too near the boiling point of the liquid, or low on account of dissociation, as in the case of ammonium chloride or of phosphorus pentachloride. In a similar manner the molecular weights of most acids when determined in solution in benzene are twice their normal value, while the molecular weights of electrolytes dissolved in water, and sometimes when dissolved in other solvents, are less than we should expect. In addition to the modifications of the law due to association and dissociation are other modifications similar to the modification of the laws of Boyle and Charles for gases which are highly compressed. These cases have been studied and formulæ for the deviation, based on the formulæ of van der Waals for compressed gases, have been given by Ostwald, Bredig and A. A. Noyes.[17] These formulæ give a satisfactory expression for the deviation in many cases of concentrated solutions. When we consider that strong solutions often give osmotic pressures of many atmospheres, and that the molecules of the bodies in solution are often much more complex than the molecules of most gases, it is readily seen that deviations of considerable amount may be expected.

In 1884 Arrhenius[18] published the results of researches on the electrical conductivity of solutions, on which he had been engaged for two years. In the course of his studies he was led to the conclusion that only a part of the molecules of an electrolyte are concerned in conveying the electrical current, and that it is necessary to distinguish between "active" and "inactive" molecules in this regard. The conductivity is greater, in proportion to the amount of the electrolyte present, for dilute than for concentrated solutions, and for an infinite dilution the molecules would, presumably, become all "active." Arrhenius pointed out, also, that there is a close connection between the number of "active" molecules as determined by the electrical conductivity of solutions, and the "avidity" of acids as determined by the thermo-chemical researches of

Thomsen. His first explanation of the cause of the difference between the "active" and "inactive" molecules, was, however, unsatisfactory and was not well received.

Shortly after, in his first development of his theory of solutions, van't Hoff was compelled to admit that many substances in aqueous solutions cause a depression of the freezing point much greater than they should in proportion to their molecular weights. He expressed the deviation by the use of a factor, "i," which is, for electrolytes, always greater than unity and expresses the number of times the depression exceeds the theoretical depression as calculated from the molecular weight. This factor was at first considered to be a constant, but it is now known that it is variable and that it increases with the dilution. The obvious meaning of this factor is that the molecules of electrolytes are separated into two or more parts when dissolved in water, or other liquids which have a similar effect in causing electrical conductivity. But, just as chemists were very slow to see that the abnormal densities of ammonium chloride and of many other substances are due to dissociation, so van't Hoff did not draw a conclusion which seemed to be so contradictory to all preconceived notions about the bodies in question. Arrhenius, however, saw the logical conclusion, and his studies had prepared him for its acceptance. As a result, he proposed, in 1887, his theory of electrolytic dissociation.[19]

This theory, which seemed at first very improbable, has shown itself capable of coördinating the facts of many diverse fields of work and has proved more valuable in the incentive which it has given to research and more prolific of results than any other theory proposed during the last decade. According to the theory, an electrolyte when dissolved in water, and sometimes when dissolved in other solvents, is separated more or less completely into its ions.

The empirical basis for the theory lies in the correspondence between electrolytic conductivity and the divergence from the normal depression of the freezing point and lowering of the vapor pressure; in the correspondence of both with the "avidity" of acids which has already been referred to; in the quantitative connection between each of these and the chemical effect of acids as shown in the inversion of cane sugar and saponification of methyl acetate; in the satisfactory explanation which it gives for the independent migration of ions during electrolysis as established by the work of

Hittorf, Kohlrauch, and others; in the fact that an electrolyte obeys the same law for dissociation with increasing dilution as a gas under diminishing pressure, first pointed out theoretically by Ostwald and Planck,[20] and then experimentally established by Ostwald, Wildermann,[21] Loomis,[22] and others; and, in general, by the fact that the properties of a dilute solution of an electrolyte are dependent on the sum of the properties of the ions present rather than on the properties of the chemical compound which those ions may combine to produce. It would take me too far to illustrate this last statement as shown to be true of the density, color and other properties of solutions.

The theory has thrown light upon many chemical riddles and has placed the chemist in a position to predict phenomena which could formerly be known only as the result of experiment. It suggests at once the distinction between reactions of ions and reactions of bodies which do not undergo ionic dissociation. The former take place in solutions at ordinary temperatures and so instantaneously that the time factor cannot be measured; the latter frequently require an elevated temperature and are sometimes very slow. The distinction is, perhaps, a practical, rather than a strictly logical one, for theoretical considerations lead us inevitably to the conclusion that only additive reactions, and in many cases not even those, can take place without a previous dissociation of some sort. In this view, the distinction between ionic reactions and others is that in solutions of electrolytes a considerable portion of the compounds have undergone dissociation; and as any ion is removed by precipitation, or otherwise, the remainder of the compound of which it is a part undergoes rapid dissociation owing to the resulting dilution of the solution. In such cases the dissociation appears to take place almost exclusively at one point in the compound, and the reactions are clean and practically quantitative. In what may be called non-ionic reactions, on the other hand, the initial dissociation appears to be trifling and, notably with organic compounds, may take place at several points; the reactions between the resulting parts must be slow and may give rise to a variety of compounds.

In accordance with the theory, only those elements or groups which exist as independent ions in a solution enter readily into combination with other ions. Hence an atom which forms a part of a complex ion as the iron of ferro- or ferri-cyanides and the

chlorine of chloro-platinic acid and of potassium chlorate cannot be detected by the ordinary reagents for these elements. This principle is of fundamental importance for analytical chemistry and has, of course, in its empirical form, been long recognized.

In the case of analytical chemistry, especially, the new theories of physical chemistry seem destined to transform what has been, hitherto, an almost exclusively empirical science and raise it to a higher plane. Two illustrations of practical applications of the theory in this field may be of interest.

The first is with regard to the indicators used in acidimetry. It has long been known that the same indicator is not equally satisfactory in all cases, but the reason has never been clearly stated till recently. The principles on which the discussion depends are these: an acid solution is characterized by the presence of free hydrogen ions, a basic solution by the presence of free hydroxyl and free metallic ions; in the case of a strong acid or base the number of hydrogen or hydroxyl ions is large in proportion to the quantity of the acid or base present, while in the case of a weak acid or base the number of ions is small; in other words the difference between strong and weak acids and bases is that the dissociation factor of the former is very much the larger. The indicators in use are relatively weak acids or bases for which the free ions possess a different color from that of the pure acid or base. Thus phenol phthaleïn is colorless, while its ion is red; litmus is red, while its ion is blue. In the presence of hydrogen ions the dissociation of each of these substances is diminished in accordance with the well known law of dissociation that the presence of one of the products of dissociation decreases the dissociation of the compound. Hence in acid solutions these bodies are so little dissociated that the color of the compound and not that of the ion appears. In alkaline solutions, however, the color of the ions is developed since the potassium and sodium salts, even of very weak acids, are largely dissociated in dilute solutions.

There is, however, a very considerable difference in the dissociation factors for the different indicators. The dissociation factor is much higher for methyl orange and for cochineal than for litmus and phenol phthaleïn, and while the dissociation factor of hydrochloric and similar acids is so high that a very small excess will cause the change in color, even of methyl orange, the dissociation factor for many acids, and especially for most organic acids, is so

low that a quite appreciable excess is required, and the change in color will be slow and uncertain. Hence methyl orange and cochineal are entirely unsuited for the titration of weak acids, and litmus or phenol phthaleïn must be used. For weak bases, and notably for ammonia, the conditions are reversed. The salts of such bases with phenol phthaleïn, or with litmus, undergo hydrolysis in dilute solutions and a considerable excess of the base will be required before the ions characteristic of the indicator will appear. The salts of the same bases with methyl orange or cochineal are not so readily hydrolyzed and these indicators are more suitable.

A practical complication arises from the presence of carbonic acid in most of the solutions which we titrate. I will not take the time here to discuss the details of the theory which points out very clearly that, for accurate results, carbonic acid must be excluded from solutions in which litmus or phenol phthaleïn are employed, while, if concentrated, methyl orange or cochineal may be used satisfactorily, for strong acids.

The other illustration of the application of the principles of physical chemistry to an analytical problem is one recently given by Stefan Bugarsky.[23] A great many methods for the separation of bromine and chlorine have been developed but nearly or quite all of them rest on a purely empirical basis. Bugarsky has studied the subject from an entirely different point of view. Sometime since Bancroft[24] determined the electromotive forces developed between oxidizing and oxidizable solutions connected by an indifferent electrolyte, and with a platinum electrode immersed in each. The results may be considered as giving a quantitative expression for the relative oxidizing and reducing power of the various substances studied. Among other things it was found that, no matter what substance was oxidized, iodic acid with sulphuric acid develops a greater electromotive force than bromine with potassium bromide and less than chlorine with potassium chloride. It appears, therefore, that iodic and sulphuric acids together should liberate bromine but not chlorine from a solution containing bromides and chlorides. The practical application of this theoretical conclusion appears to have been entirely successful.

It is not alone in chemistry that the theories of osmotic pressure and of electrolytic dissociation have proved of practical value. Nernst has developed from these theories a theory for the cause of the electromotive force in batteries, which, while it may not, as

yet, have received general acceptance, is a more useful expression for our present knowledge than any previously proposed. The most important conception at the basis of this theory is that of what may be called a solution pressure for metals, corresponding in some sense to the vapor pressure of liquids. When zinc, for instance, is in contact with water, or an aqueous solution, this solution pressure is a force impelling the atoms of zinc to pass into solution. In order that they may do so, however, each atom must pass over into the state of an ion; that is, it must receive a charge of positive electricity which is carried with it into the solution. But only a very few atoms can pass into solution before the negative charge left in the mass of the zinc in proportion as the positive ions separate from it will cause such an accumulation of zinc ions in proximity with the zinc as to balance the solution pressure. If, however, an opportunity is given for the escape of the negative charge from the zinc and at the same time positive ions are allowed to escape from the solution at some other point, the zinc will continue to dissolve and currents of electricity will be set up. Thus, in the Daniell or gravity cell, zinc ions pass into solution, and a corresponding number of copper ions are deposited. The force which causes the movement of the ions and with them the transference of electrical energy within the cell is mainly the very high solution pressure of the zinc as compared with that of copper. Other factors, such as the osmotic pressure of zinc ions already in solution which tends to counteract the solution pressure of the zinc, the osmotic pressure of copper ions which aids in the separation of the copper, and the different velocity of translation for various ions which may cause differences of potential when the fluids of the cell are not homogeneous, are most of them comparatively small in their effect.

No means has been found for the direct determination of the solution pressure of metals, but it may be calculated from the difference in potential between a metal and a solution of one of its salts. Methods for the determination of the latter have been devised by Ostwald,[25] and improved by Paschen.[26] By the use of these and other constants which the researches of physical chemistry have placed in his hands, the physicist can now calculate the electromotive force which can be obtained by various combinations of metals and solutions. On this side the theory has rendered essentially the same service for the galvanic cell which the atomic theory rendered for chemical compounds when it furnished the

means for calculating their percentage composition. As in the early days of the atomic theory, many of the constants in question are imperfectly known, but since the theory has shown clearly their interdependence, new means for their determination and for the control of their accuracy are constantly being discovered.

Every one who is familiar with the extremely wasteful character of all processes now at our disposal for the transformation of chemical into mechanical energy must have had the thought that there is surely some means of saving a part of the enormous loss. At present the attention of the scientific world is turned toward the transformation of the chemical energy of coal into electrical energy as the probable solution of this problem. It seems to be almost certain that physical chemistry has already made clear the principles by means of which such a transformation may be accomplished. Indeed, Dr. W. Borchers,[27] by the use of a solution of cuprous chloride with producer gas, or carbon monoxide on one side and air on the other, has already obtained an electrical current which corresponds to a transformation of thirty per cent of the chemical energy into electrical. This is an efficiency three times that of the best steam engines. There is no probability that this method can ever be practically useful, but that a practical method will soon be discovered is, at least, possible.

I have thus far spoken of the achievements of physical chemistry mainly in the direction of the development of the theories of osmotic pressure and of electrolytic dissociation. It is in this field that the most valuable practical results have been secured because it is here that a new, far-reaching, and extremely useful theory has been developed. But work in physical chemistry has been extremely active in many other directions as well.

The most brilliant chemical discovery of the last decade was a result of the careful study of a single physical property of nitrogen. And, owing to the peculiar character of argon and helium, their further study has been almost exclusively on the physical side.

Ramsay and Shields[28] by their work on the surface energy of homogeneous liquids have developed a method for the determination of the molecular weights of this class of bodies.

Traube's exhaustive study of the specific gravity of solutions, promises, if all that he claims be true, and much of it seems to be, to bring order out of an almost interminable chaos of empirical data. Among other things his work has given a new and very rapid method for the determination of molecular weights.

I will not take the time to refer in detail to the work of Brühl and others on the refraction and dispersion of light as dependent on the composition and structure of bodies; to the work of Thomsen, of Stohman and of Berthelot upon thermo-chemistry; to the work of Guye, Walden and others on specific and molecular rotation and of Perkin on electro-magnetic rotation of polarized light; and to the work of Rowland on spectrum analysis.

In all of these fields and in many others a vast accumulation of empirical data has been secured. This wealth of experimental material has been accompanied and supplemented by theoretical discussions and many interesting relations have been discovered. Physical chemistry has proved one of the most enticing and profitable fields for work in recent years and claims many enthusiastic investigators in our own country as well as abroad. In the development of the subject perhaps no one has contributed more than Ostwald by his Lehrbuch and by his ably edited Zeitschrift für physikalische Chemie. We may congratulate ourselves that our workers in America are now to have a journal of their own, and we may confidently hope that the new Journal of Physical Chemistry will contribute much toward "the chemistry of the future."

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PAPERS READ.

BEGINNING TUESDAY, AUGUST 25.

PHYSICAL CHEMISTRY.

DETERMINATION OF OSMOTIC PRESSURE FROM VAPOR PRESSURE MEASUREMENTS. By Prof. A. A. NOYES and G. C. ABBOTT, Mass. Inst. of Tech., Boston, Mass. (To be published in *Zeitschrift für phys. Chemie.*)

DISTILLATION WITH VAPOR. By Prof. W. D. BANCROFT, Cornell University, Ithaca, N. Y. (To be published in *Journal of Physical Chemistry.*)

A PHYSICO-CHEMICAL STUDY OF WATER SOLUTIONS OF SOME OF THE ALUMS. By H. C. JONES, Johns Hopkins University, Baltimore, Md.

THE HYDROLYSIS OF THE SULPHONIC ETHERS. By Prof. J. H. KASTLE, State College of Kentucky, Lexington, Ky.

ON THE NATURE OF ISOMORPHOUS MIXTURES. By C. E. LINEBARGER, Chicago.

A DISCUSSION OF LICHTY'S EXPERIMENTS ON THE SPEED OF ESTERIFICATION. By Prof. ROBERT B. WARDER, Howard University, Washington, D. C. (To be published in *Journal of Physical Chemistry.*)

THE HYDROLYSIS OF FERRIC CHLORIDE. By H. M. GOODWIN, Mass. Inst. of Tech., Boston, Mass.

THE VISCOSITY OF MERCURY VAPOR. By Prof. A. A. NOYES and H. M. GOODWIN, Mass. Inst. of Tech., Boston, Mass.

INORGANIC CHEMISTRY.

SOME POINTS IN NOMENCLATURE WITH REGARD TO ANALYSIS OF MINERAL WATER. By Prof. F. W. CLARKE, U. S. Geol. Survey, Washington, D. C.

THE ALKALI TRIHALIDES. By Dr. C. H. HERTY and H. V. BLACK, University of Georgia, Athens, Ga. (To be published in *Amer. Chemical Journal.*)

THE METAMORPHOSIS OF FOSSIL BONE INTO A MINERAL. By E. GOLDSMITH, Philadelphia, Pa.

A BIBLIOGRAPHY OF THE METALS OF THE PLATINUM GROUP. By Prof. JAS. LEWIS HOWE, Washington and Lee University, Lexington, Va. (To be published in *Smith. Miscel. Col.*)

EXAMINATION OF WATER AND DEPOSITS FROM A LAKE IN YUCATAN. By Prof. JAS. LEWIS HOWE and Prof. H. D. CAMPBELL, Washington and Lee University, Lexington, Va. (To be published in *Amer. Jour. Science.*)

A REVISION OF THE ATOMIC WEIGHT OF MAGNESIUM. By Prof. T. W. RICHARDS and H. G. PARKER, Harvard University, Cambridge, Mass. (To be published in *Zeit. anorg. Chemie.*)

ORGANIC CHEMISTRY.

HYDRAZONES OF QUINONES. By Prof. WM. MCPHERSON, Ohio State University, Columbus, Ohio.

SYNTHESIS OF DIETHYL-HEXAMETHYLENE ETHER AND OTHER ETHERS FROM TRIMETHYLENE GLYCOL. By Prof. A. A. NOYES, Mass. Inst. of Tech., Boston.

FORMATION OF DIACETYLENYL (BUTADIINE) FROM COPPER ACETYLENE. By Prof. A. A. NOYES and C. W. TUCKER, Mass. Inst. of Tech., Boston.

CAMPHORIC ACID. By W. A. NOYES, Rose Polytechnic Inst., Terre Haute, Ind.

INTRODUCTION OF ALKYL RADICLES INTO PHOSPHINE BY MEANS OF ETHERS. By Dr. P. FIREMAN, Columbian University, Washington, D. C.

DIPYRIDINE METHYLENE IODIDE AND THE NON-FORMATION OF CORRESPONDING MONOPYRIDINE PRODUCTS. By S. H. BAER and Prof. A. B. PRESCOTT, University of Michigan, Ann Arbor, Mich.

ALKYL AMMONIUM IODIDES IN REACTION WITH BISMUTH SALTS. By S. H. BAER and Prof. A. B. PRESCOTT, University of Michigan, Ann Arbor, Mich.

ON THE BEHAVIOR OF TRICHLORDINITROBENZOL WITH VARIOUS REAGENTS. By Prof. C. LORING JACKSON and W. R. LAMAR, Harvard University, Cambridge, Mass.

ON THE ACTION OF NITRIC ACID ON POTASSIC COBALTICYANIDE. By Prof. C. LORING JACKSON and A. M. COMEY, Harvard University, Cambridge, Mass.

ON THE ACTION OF SODIC ETHYLATE ON DINITRANISSIC ACID. By Prof. C. LORING JACKSON and M. H. ITTNER, Harvard University, Cambridge, Mass.

DIDACTIC CHEMISTRY.

POINTS IN TEACHING TECHNICAL CHEMISTRY. By Prof. T. H. NORTON, University of Cincinnati, Cincinnati, Ohio.

ON SOME NEW FORMS OF GAS GENERATORS. By Prof. T. H. NORTON, University of Cincinnati, Cincinnati, Ohio. (To be printed in *Jour. Amer. Chem. Soc.*)

THE AIM OF QUALITATIVE ANALYSIS. By Prof. G. C. CALDWELL, Cornell University, Ithaca, N. Y.

THE TEACHING OF QUALITATIVE ANALYSIS. By Prof. A. L. GREEN, Purdue University, La Fayette, Ind.

THE USE OF THE PERIODIC LAW IN TEACHING GENERAL CHEMISTRY. By Prof. F. P. VENABLE, University of North Carolina, Chapel Hill, N. C.

CHEMISTRY AT THE RENSSELAER POLYTECHNIC INSTITUTE. By Prof. W. P. MASON, Rensselaer Polytechnic Institute, Troy, N. Y.

LABORATORY INSTRUCTION IN ORGANIC CHEMISTRY. By Prof. A. A. NOYES, Mass. Inst. of Tech., Boston.

THE TEACHING OF PHYSICAL CHEMISTRY. By Prof. A. A. NOYES, Mass. Inst. of Tech., Boston.

INSTRUCTION IN SANITARY CHEMISTRY AT THE MASS. INSTITUTE OF TECHNOLOGY. By ELLEN H. RICHARDS, Mass. Inst. of Tech., Boston.

SOME POINTS IN THE USE OF DEPTHS OF COLOR AS A MEASURE OF CHEMICAL CONTENTS. By ELLEN H. RICHARDS, Mass. Inst. of Tech., Boston.

ANALYTICAL CHEMISTRY.

NOTES ON REINSCH'S TEST FOR ARSENIC AND ANTIMONY. By Prof. J. L. HOWE and P. S. MERTINS, Washington and Lee University, Lexington, Va. (To be published in *Jour. Amer. Chem. Soc.*)

A NEW FORM OF LABORATORY CONDENSER. By ERWIN E. EWELL, Dept. of Agriculture, Washington, D. C.

A METHOD OF MANIPULATION FOR THE COLORIMETRIC DETERMINATION OF AMMONIACAL NITROUS AND NITRIC NITROGEN IN BACTERIAL CULTURE. By EDWIN E. EWELL, Dept. of Agriculture, Washington, D. C.

A MODIFIED FORM OF THE EBULLIOSCOPE. By Prof. H. W. WILEY, Dept. of Agriculture, Washington, D. C.

TECHNICAL CHEMISTRY.

RECENT DEVELOPMENTS IN THE PURIFICATION AND FILTRATION OF WATER. By Prof. A. R. LEEDS, Stevens Institute, Hoboken, N. J.

ON THE COMPOSITION AND PROPERTIES OF NATURAL GAS FROM WESTERN PENNSYLVANIA. By Prof. FRANCIS C. PHILLIPS, Western University, Allegheny, Pa.

A METHOD FOR THE DETERMINATION OF SULPHUR IN WHITE CAST IRON. By Prof. FRANCIS C. PHILLIPS, Western University, Allegheny, Pa.

THE MEANING OF THE TERM "OXYGEN CONSUMED" IN THE REPORT OF A WATER ANALYSIS. By ELLEN H. RICHARDS, Mass. Inst. of Tech., Boston.

ON RECENT IMPROVEMENTS IN THE MANUFACTURE OF SULPHURIC ACID. By Dr. C. L. REESE, The Citadel, Charleston, S. C.

USE OF COAL TAR COLORS IN FOODS. By Prof. H. A. WEBER, Ohio State University, Columbus, Ohio. (To be printed in *Jour. Amer. Chem. Soc.*)

THE ALKALOIDS OF ANHELONIUM LEWINII (MESCAL BUTTONS). By ERWIN E. EWELL, Department of Agriculture, Washington, D. C. (To be printed in *Jour. Amer. Chem. Soc.*)

SANITARY CHEMISTRY.

NOTES ON WELL WATER. By Dr. W. P. MASON, Rensselaer Polytechnic Inst., Troy, N. Y.

VALUE AND USE OF FORMALDEHYDE AS A DISINFECTANT. By Dr. E. A. DE SCHWEINITZ, Dept. of Agriculture, Washington, D. C.

OBSERVATIONS ON THE SANITARY NATURE OF THE MISSISSIPPI RIVER WATER AT DIFFERENT SEASONS. By Prof. E. G. SMITH, Beloit College, Beloit, Wis.

AGRICULTURAL CHEMISTRY.

THE WORK OF THE AGRICULTURAL CHEMISTS OF AMERICA. By L. L. VAN SLYKE, Geneva, N. Y.

CONDITIONS AFFECTING THE NORMAL VISCOSITY OF MILK. By Prof. S. M. BABCOCK and Prof. H. L. RUSSELL, University of Wisconsin, Madison, Wis. (To be printed in 13*th Report of the Wisc. Exper. Station.*)

ON THE RESTORATION OF THE VISCOSITY OF PASTEURIZED MILK AND CREAM. By Prof. S. M. BABCOCK and Prof. H. L. RUSSELL, University of Wisconsin, Madison, Wis. (To be printed in 13*th Report of the Wisc. Exper. Station.*)

BIOLOGICAL CHEMISTRY.

THE NECESSITY OF ANIMAL EXPERIMENTATION IN THE STUDY OF BIOCHEMISTRY. By Dr. E. A. DE SCHWEINITZ, Dept. of Agriculture, Washington, D. C.

ANDROMEDOTOXIN, THE POISONOUS CONSTITUENT OF THE ERICACEÆ AND ITS RELATION TO SOME FOOD PRODUCTS. By V. K. CHESTNUT, U. S. Dept. of Agriculture, Washington, D. C.

The Section adjourned Thursday evening, August 27.

Fourteenth Annual Report of the Committee on Indexing Chemical Literature.

The Committee on Indexing Chemical Literature presents to the Chemical Section its fourteenth annual report. During the year ending August, 1896, there has been exhibited much activity in chemical bibliography and indexing; several valuable works have been completed and many important undertakings have been begun.

WORKS PUBLISHED.

A Dictionary of Chemical Solubilities. Inorganic. By Arthur Messinger Comey. New York and London, 1896. pp. xx—515. 8vo.

Professor Comey is to be complimented on the completion of the first part of his extensive undertaking, and chemists are to be congratulated on the publication in such good form of so important an aid to research. It is to be hoped that this volume will be so well received as to encourage the author to follow promptly with the organic section.

Index to the Literature of the Detection and Estimation of Fusel Oil in Spirits, by W. D. Bigelow. *J. Amer. Chem. Soc.*, Vol. xviii, No. 4, p. 397.

This was announced in our report for 1895.

Bibliography of Embalming, in a Thesis entitled: "Embalming and Embalming Fluids," by Charles W. McCurdy (of the University of Idaho). *Post-Graduate and Wooster Quarterly*, April, 1896.

A very full bibliography of this unique subject, which has its chemical aspects as well as its grave ones. It comprises about 500 entries, in several modern languages, arranged alphabetically by authors.

References to Capillarity, by John Uri Lloyd. In his "Study in Pharmacy." Privately printed. Chicago, 1895-96. 8vo.

Atomic Weights form the subject of a brief bibliography (24 titles) accompanying an article on the same topic by Alexander Scott. *Science Progress*, Vol. 1, p. 542 (Aug., 1894).

The Composition of Water, a short bibliography, by T. C. Warrington. *Chem. News*, Vol. 73, p. 137 *et seq.* (March, 1896).

A Short List of Books on Chemistry. Selected and annotated by H. Carrington Bolton. *Scientific American Supplement,* Oct. 19, 1895.

Bibliography as a Feature of the Chemical Curriculum. By H. Carrington Bolton. *Science,* Oct. 4, 1895.

Review of American Chemical Research, edited by Arthur A. Noyes. In the *Technology Quarterly,* issued by the Massachusetts Institute of Technology, Boston, Mass.

The first paper appeared in the number for April, 1895 (Vol. viii, p. 90); the reviews consist of abstracts of papers in periodicals, grouped under the following heads: General and Physical Chemistry, Inorganic, Organic, Technical, Sanitary, Agricultural, Vegetable, Metallurgical, Assaying, Geological, Mineralogical, Apparatus. Each abstract is signed by the abstractor.

This Review promises to be an important contribution to contemporary chemical science of America, and deserves to be well supported.

Enumeration of Titles of Chemical Papers. This bibliography has been published monthly since May, 1894, in *Science Progress,* London. It embraces titles (without comments) in several European languages.

Bibliography of Agricultural Chemistry (American).

The several publications of the scientific bureaus of the United States Government contain many valuable contributions to chemistry in its applications to agriculture and the arts, widely scattered in their pages, and it has been difficult to keep informed with reference to them. Thanks, however, to the excellent bibliographical work of the Office of Experiment Stations, U. S. Department of Agriculture, Washington, D. C., the chemical treatises published in the Bulletins of the State Institutions are made accessible; this is accomplished in the three publications here named:

Experiment Station Record, Vol. iii, No. 12 (July, 1892). *Bulletin* No. 9 (1894), and *Bulletin* No. 23 (1895). Organization-Lists of the Agricultural Experiment Stations, U. S. Department of Agriculture, Office of Experiment Stations.

These contain: "Lists of Station Publications," giving dates, bulletin-numbers, and titles of each bulletin, under each State, alphabetically arranged. For the agricultural chemist these bibliographical helps are too important to be overlooked.

The Committee also chronicles the publication of the following valuable aids to chemical research:

Synopsis of Current Electrical Literature during 1895. By Max Osterberg. New York (D. van Nostrand Co.), 1896. pp. xiii-143. 8vo.

This is a classified index, with an index to authors, compiled from fifty-nine foreign and American periodicals; it is intended to be published annually.

General-Register zu Ladenburg's Handwörterbuch der Chemie. Breslau, 1895. pp. 160. 8vo.

Bibliographie des travaux scientifiques . . . publiés par les sociétés savantes de la France, dressée sous les auspices du ministère de l'instruction publique; par J. Deniker. Paris, 1895. 4to.

Reports of Progress.

The Index to the Mineral Waters of the World, by Dr. Alfred Tuckerman, noticed in previous reports, has been completed and accepted for publication by the Smithsonian Institution.

The manuscript of a new edition of the "Catalogue of Scientific and Technical Periodicals, 1665-1882," by Dr. H. Carrington Bolton, has been completed and is now going through the press. The new edition will be issued by the Smithsonian Institution as a volume of the Miscellaneous Collections. The bibliography includes chemical journals, and is brought down to the year 1895.

Dr. Bolton reports progress on a Supplement to his "Select Bibliography of Chemistry, 1492-1892," the printing of which is however postponed.

Professor James Lewis Howe reports the completion of the manuscript of an Index to the Literature of Platinum and its Compounds; this will be presented to the Chemical Section at the same session with this report.

Professor F. P. Venable has completed an Index to the Literature of the Periodic Law. It will accompany his "Development of the Periodic Law," soon to be published by the Chemical Publishing Co., Easton, Pa.

Works in Preparation.

Dr. Alexis A. Julien has no less than three bibliographical works well advanced: (1) A Bibliography of Sand (including chemical analysis, etc.).

(2) A Bibliography of Pedesis, or the Brownian movement.

(3) A Bibliography of the Condensation of Gases on the surface of Solids.

Dr. Arthur C. Langmuir is engaged on an Index to the Literature of Zirconium.

Mr. George Wagner, of the University of Kansas, has undertaken an Index to the Literature of Oxygen, on a large scale. In this work he will have the counsel of Professor Albert B. Prescott.

Dr. C. H. Joüet has the manuscript of an Index to the Literature of Thorium well advanced towards completion.

Professor Rudolph A. Witthaus has compiled a Bibliography of Forensic Toxicology, which will appear in Vol. IV of Witthaus and Becker's Medical Jurisprudence, New York, 1896.

The Journal of the Society of Chemical Industry announces a Collective-Index for the whole series, 1881-1895. This is to be ready in 1896 and will form a volume of about 500 pages quarto.

Attention is called to a plan for facilitating bibliographical researches, adopted by the American Pharmaceutical Association. The Research Committee of this Association employs a Reference Reader whose duty it is to supply original literature to investigators working in the Committee and with it. A list of the chief serials and a few encyclopedic works is placed in the hands of those who apply for the services of the Reader. Transcripts, abstracts and translations are supplied. The service is chiefly for literature beyond the smaller libraries, and is under the direction of the Chairman of the Committee.

Perhaps a similar scheme might be organized within the American Association for the Advancement of Science.

In conclusion, the Committee on Indexing Chemical Literature desires to state to those not acquainted with the announcements made in the preceding annual reports, that it labors to foster individual undertakings in chemical bibliography, to prevent futile duplication of work, to record in these reports completed bibliographies and new enterprises, as well as to chronicle progress in bibliography in lines bordering on chemistry. Suggestions as to topics, methods, channels of publication, etc., will be cordially furnished by the Committee. Address correspondence to the Chairman, at Cosmos Club, Washington, D. C.

Committee,
H. CARRINGTON BOLTON, *Chairman*,
F. W. CLARKE,
A. R. LEEDS,
A. B. PRESCOTT,
ALFRED TUCKERMAN,
H. W. WILEY.

RESOLUTIONS OF THE SECTION.

Professor W. P. MASON moved that a committee of five, with advisory power, be appointed by the Vice-President to consider the possibility of combining the meeting of the Section with that of the American Chemical Society, so that both should come within the same five or six days.

This was amended by Professor CLARKE so that the Vice-President for the Section should be a member and chairman of the committee.

The amendment and motion were carried. The Vice-President appointed the committee as follows: Vice-President W. A. NOYES, WM. P. MASON, A. B. PRESCOTT, T. H. NORTON, WM. MCMURTRIE.

A report was made by this committee on August 27, said committee favoring the assignment of the first two days of the session of the Section to the Society, with the condition that opportunity be given for the organization of the Section and for the Vice-President's address.

The report was adopted.

Dr. HART reported progress in his work upon Glucinum, for which he has received a grant from the Research Fund of the Association. Dr. SPRINGER moved a vote of thanks to Dr. HART from the Section, and the indorsement of the work. This was carried.

The nomination by the Council of Professor Emeritus WOLCOTT GIBBS of Harvard University for Honorary Fellowship in the Association was approved by the Section.

SECTION D.

Mechanical Science and Engineering.

OFFICERS OF SECTION D.

Vice-President and Chairman of the Section.

Frank O. Marvin, Lawrence, Kan.

Secretary.

John Galbraith, Toronto, Canada.

Councillor.

Thomas Gray, Terre Haute, Ind.

Sectional Committee.

Frank O. Marvin, Lawrence, Kansas, Vice-President, 1896.
John Galbraith, Toronto, Canada, Secretary, 1896.
William Kent, Passaic, N. J., Vice-President, 1895.
Henry S. Jacoby, Ithaca, N. Y., Secretary, 1895.
H. T. Eddy, Minneapolis, Minn.
D. S. Jacobus, Hoboken, N. J.
O. H. Landreth, Schenectady, N. Y.

Member of Nominating Committee.

Mansfield Merriman, South Bethlehem, Pa.

Committee to Nominate Officers of the Section.

The Vice-President and Secretary; and Storm Bull, Madison, Wis.; W. M. Towle, State College, Pa.; H. S. Jacoby, Ithaca, N. Y.

Press Secretary.

J. Galbraith, Toronto, Canada.

ADDRESS

BY

VICE-PRESIDENT

FRANK O. MARVIN,

CHAIRMAN OF SECTION D.

THE ARTISTIC ELEMENT IN ENGINEERING.

A FRIEND of the writer, a successful business man and much interested in things artistic, when informed of the choice of subject for this paper, gave expression to a feeling of surprise, doubting if there was any relation between engineering and æsthetics.

One of the leading engineers of America once asked a professional brother what he did for recreation, and, on being told of a modest interest in pictures and music, likewise expressed surprise, saying, "You are the first engineer that I have ever known to be a musician." There was also an implication, though unintentional, of a diminished respect, — perhaps on both sides.

These two incidents may be taken to typify in a general way the attitude that is held by the business world on the one side, and the engineering fraternity on the other, toward the relationship which it is here proposed to discuss.

That the artistic element is not recognized as it might or ought to be in the present American day is natural. The rapid development and growth of our land, the intensive study of science and the concentration of the effort put forth to adapt it to every-day affairs, have exalted one phase of the economic idea, the quick attainment of profitable results, and clouded the truer, broader meaning that looks toward the best things and the highest life of the people. Into the midst of this active, restless, business life entered the engineer, doing more and more of its work and becoming more and more a recognized part of it and an undisputed element

in its growth. He has acquired the characteristics of the life about him, — zeal, energy, alertness, readiness in meeting quickly changing conditions, and absorption in the work in hand. He plans rapidly, and executes to-day with an eye for to-morrow's profits. As another has said, "The world measures the efficiency of the engineer in dollars and cents," just in fact as it measures that of any other man, and engineers, as other men, largely accept the standard.

Time was when he was only the tool of some business man who had money to expend in a certain way, and who employed him, under direction, because of some individual ability. But times are changing. In place of the isolated worker there is growing up a profession with professional standards and an *esprit de corps*, whose members are to be retained, not hired. Cultured, and with the openness and clearness of mind that only come from deep study, broad training, and large experience, these are to be people of influence whose advice and services are sought, leaders whose judgments are respected, and men who can mingle with the best anywhere on a common ground of attainment and character. They are to be intrusted with the expenditure of public funds in increasing extent, and with an augmenting confidence. The very nature of an engineer's qualifications, his technical knowledge, the cultivation of his judicial and critical faculty, his training in fidelity to the trusts reposed in him by private clients, — all these fit him for places of large responsibility concerned with public works, and the people, tired of political management, arê beginning to find this out.

These are no new thoughts, though none the less true, for others have recently written in confident strain of the coming engineer of the twentieth century. Yet it should be emphasized that the desired change is not after all so far ahead of us. To some extent at least the coming engineer has already arrived and is making himself felt. The leaven is at work.

With an engineering practice based solely on immediate results by way of expected profits in dollars and cents the æsthetic element has little to do, though even here its absence may mean financial loss. But from the standpoint of this paper, engineering is to be considered in the broader light of Tregold's well known definition, "The art of directing the great sources of power in nature for the use and convenience of man," while the engineer is

he who designs and executes engineering works. It is not necessary here to dwell upon the breadth and comprehensiveness of these simple fundamental statements, but let us not forget that they *are* broad and comprehensive. With an engineering practice based on a generous interpretation of the above, the artistic has much to do.

The engineer is primarily a designer. He works with the materials of Nature as his medium and her powers as his tools wherewith to express his thought and his purpose to serve and benefit man. Just as in the making of a picture the brushes, paint, and canvas are not the chief things, so here it is not the wood, steel, and brass, or the powers of gravity, steam, air, and electricity, that are most important, but rather the character and quality of the design and the degree of realization in its execution. The design may be bad or good, according as it ignores or harmonizes with principles underlying all such acts of creation. The result may be a happy one only when the means employed are rightly chosen and properly adapted to the end sought. In this process of creating something of value, something that helps man to a fuller, richer, and better life, the artistic cannot be left out. In its absence the design falls far short of its possible perfection, and man is deprived of what is due him, though not perhaps distinctly conscious of the loss. In a certain sense, then, every engineer is an artist, and in some directions at least, as in architecture and other forms of construction and in the making of public parks, the result of his cultured brain may attain to the dignity of a work of "fine art." Perhaps, in its true essence, there may be as much fine art in the design of a machine to produce bolts as there is in the making of a picture for the Salon; certainly the well planned tool, with fine proportions and parts perfectly related, is above the poor canvas.

To every true man there is a joy in creation that is not satisfied with anything less than the best of which he is capable. As Emerson has said, "I look on that man as happy, who, when there is question of success, looks into his work for a reply, not into the market, not into opinion, not into patronage. . . . What is vulgar, and the essence of all vulgarity, but the avarice of reward? 'T is the difference of artisan and artist, of talent and genius, of sinner and saint." But beyond this, which is the purely personal side of the matter, lies service, the designing for the use and

convenience of man. From the vantage ground of his position as a man of educated intelligence and trained ability, the engineer owes the world his best effort. It needs and asks for technical skill and scientific knowledge whereby to-day's work may be done. But also, without knowing exactly what it wants, it feels the need of those added qualities it cannot define, and seeks for guidance and help to something better for to-morrow. In the long run, it will honor the man that meets the demand, and will measure his efficiency on more grounds than that of dollars and cents.

To the superficial or hasty thinker there may appear a conflict here between the utilitarian and the artistic, but there can be no real antagonism. The result of any act of designing is to be judged as a whole and in the light of all the purposes to be fulfilled. The physical conditions imposed by the materials used and the forces of nature employed are to be met. These conditions must be expressed in the design frankly and candidly, and in such a way as to indicate clearly its purpose, and to gratify the observer through its proportions, symmetry, harmony, and decoration. The end desired must be attained in the most direct and simple way, so that the expenditure of money may be a minimum. These are the three elements of design. The scientific, the æsthetic, and the financial. A disregard of the requirements of the first may mean structural or organic weakness on the one hand, or, on the other, an excess of material that unduly adds to the cost and at the same time may produce heaviness or ugly proportions in the completed work. Non-compliance with the demands of the second makes the design fail in fulfilling its complete mission, and this applies with the same force to those cases where a poorly directed attempt has been made to be artistic in expression, as to those in which no attention whatever has been paid to the matter. Artistic treatment often costs money, yet the mere expenditure of cash will not secure it. On the other hand, the proper display of good taste may often come without the spending of a dollar more than is made necessary by the other conditions surrounding the problem. A wealth of ornamentation may be brazen and vulgar, while beauty and grace may be found in the simple lines of a machine or bridge, or in the curving of the curb by the roadside. The disregard of the financial side may mean either a weak, meagre, and unsatisfactory result, or an unwise lavishness in expenditure; in both cases causing in the long run a loss and waste of money.

The current engineering practice gives great attention to the first and last of these elements, and but little comparatively to the second. There is no branch of it but would be benefited by adding to scientific and business ability a knowledge of the principles of artistic design, and an impulse to give expression to it. The effect on the life of our communities and the nation by such a change is not easily estimated. The writer does not expect, however, to see an immediate revolution. This is not a change that comes naturally in that way, but rather by way of development and growth, generally slow, although they may at times be accelerated. In this development our people as a whole must increase in artistic sensitiveness. We are not an æsthetic nation, but we have latent possibilities in that direction; we are young, confident, and impressionable, and have the courage to be original in design, which counts for much. We have evolved the American locomotive, the American truss bridge, the American automatic machine, the American much debated tall building, and many other things specially adapted to American needs. We shall grasp the artistic possibilities of construction quickly when we come to know what they are, and shall apply them confidently, not always at first with the most happy results. We shall learn some things from the old world and shall assimilate much that is good in its practice, but in the end engineering here will be both artistic and American.

There are evidences here and there that this process of change is going on. American machine design, when compared with that of other countries, shows some marked characteristics. A writer in the Engineering Magazine says of these: "The best ones are directness of design, by which is meant the shortest cut to reach a given end, the designer having in mind the thing to be done quite as much as the machine which is to do it; lightness and a close proportioning of parts; in machine work a near approximation to pattern; rapidity of construction and rapidity of action in the finished machine; the substitution of special steels and new alloys, hollow construction, etc., for older materials and construction, and a generally neat appearance of work, with burrs, lips, and roughness of casting removed. The American designer is not an artist, like the Frenchman, but is more attentive to appearances than the Briton. He is gradually curing himself of the tendency to tawdry ornament, needless accessories of fancy castings, stencilled paints, japanning out of place, and bright work for

mere effect." These are good qualities, and in the line of improvement. Some recent installations of power plants illustrate a movement that will have considerable influence on engine design. In many of our larger cities there are engine-rooms fitted up in elegance, with marble floors and wainscot, decorated walls and ceilings, brilliantly lighted and with all the appliances of the plant, engines, dynamos, switchboards, and even the smaller accessories in keeping with the surroundings. These plants are used as drawing cards or advertisements. There are other plants, not so used, where there is displayed less elegance, but fully as much artistic sense in adapting the room and its treatment to its purposes. In many of these places only the enclosed type of engine can be employed. In all of them the standard of maintenance must have its influence on the matter of design, which will in turn react on the former. An engine might pound itself to death in a dark basement, but would have its slightest vagary looked after in one of these better planned housings. This result cannot be entirely accounted for by the larger room, the better light, the rules and regulations. There is a refining, educating influence in these artistically planned constructions that makes better men and more efficient workmen of the attendants. Whatever they may cost, there is a credit side to the balance sheet.

Our railways are contributing toward this change. They have found the decoration of passenger trains a profitable thing, and, so stimulated, have carried it to excess. Handsome terminal stations, adorned in good taste, are supplanting the dingy, forbidding, and inconvenient places so long in use, while the shed type of depot is being crowded out by beautiful, quaint buildings, set in the midst of lawns and flower beds. More significant still is the tendency to adopt a high standard of maintenance, under which the roadbed is kept trim and neat, flanked by sodded slopes, and bordered by clean and well kept buildings, and which also requires the rolling stock, the shops, and the yards to be maintained in a high state of efficiency. This is not necessarily in itself artistic, but it furnishes at least a necessary foundation. That the railway management understands to some degree the commercial value of the artistic element in its business is further evidenced by the nature of its advertising, that seizes on any advantage of scenery or artificial effect that is at hand.

Not much can be said in praise of the artistic qualities of our

bridges, for these attributes are conspicuous through their absence. The American bridge satisfies the conditions of stability and least cost, but of beauty of line or balanced proportion that makes it fit into and harmonize with the landscape, or even that makes it considered by itself attractive, it has little. And this is to be the more regretted, because an intelligent application of right principles would improve the effect, without adding much, if any, to the cost, or making the structure less safe and durable. It is true that the truss with parallel chords, especially of the through type, does not lend itself readily to artistic treatment, yet even here something can be done. It is not so much a matter of adding ornament as the proper treatment of the organic lines, the length of spans, the relation of length of panel to height of truss, the location of the piers, and the form of their outlines. Ornamentation is not to be used so much for its own sake, but rather where it is needed to accentuate these organic markings. There are some truss bridges of such size that they give pleasure to the observer through their massiveness, though lacking in other desirable qualities. The cantilever, like the Pratt and its relatives, is difficult of treatment, while arch forms, either braced or of the suspension type, are naturally pleasing and best adapted for artistic expression. Of these types we have a few satisfactory examples, like the Eads and the Grand Avenue Bridges at St. Louis, and the Brooklyn and Washington Bridges at New York. In our public parks are to be found many small bridges of good design, while in our cities there are some creditable ones of larger dimensions. There is some tendency toward the use of curved chords in bridges designed for urban use, and a further evidence of interest in the curved line through the introduction of the Melan arch. In some respects it is unfortunate that the economical element has driven out the stone arch, which possesses so many of the features of a beautiful structure for most situations, and it may be that this new form will become a substitute for the old, with added characteristics of its own. However much we may admire the inventive genius and mechanical ingenuity of those who have worked out the types of rolling or lift bridges that cross the Chicago River, the less said about the beauty of the designs the better. Perhaps the environment imposes ugliness on the designer. But that problem is hardly solved yet, and will not be until some man gets hold of it that

combines æsthetic with scientific qualities, and has insight keen enough to see the possibilities of the situation and adroitness enough to manage, not only the physical, but also the human elements, — a rare combination.

In the entire field of engineering there is no portion of it that includes a greater variety of intricate and difficult problems for solution than that connected with municipalities. Here the engineer has to do with matters touching the home life, the dwelling, its heating, ventilation, and lighting, its drainage and water supply, etc. There is the business life that demands attention for the stores, office blocks, banks and exchanges, manufactories and shops, warehouses and elevators, with all their requirements of heating, cooling, lighting, ventilation, drainage, power, and internal communication through elevators, pneumatic systems, and alarms. Then there is the larger life of the city as a whole, that needs public buildings, churches, schools, hospitals, libraries, museums, hotels, theatres, railway stations, and markets, each with its own peculiar demands; streets and systems for rapid transit, both intramural and suburban; the distribution of water, heat, cold, light, and power; pneumatic systems for carrying packages; electrical conduits; sewerage and garbage systems, with the plants for their treatment or disposal; wharves and railway yards; parks, boulevards, playgrounds, and plazas; and the opening of new territory to accommodate the city's growth.

The engineer here comes in close contact with the people that daily and hourly use the results of his work. He already influences their health and bank accounts for the better, gives them greater ease and convenience at work or play, and saves their time. This is what is asked of him, and he meets the demand well. But what an uplift would come to city life, how much richer it would be, if he could put an artistic quality into his designing, and the people would learn to appreciate it! It is not to be inferred that there is an entire absence of this, but rather that artistic effects have been largely confined to individual cases, and not made manifest in the general life of the city.

For instance, there are numerous examples of suburban dwellings, beautiful internally and externally, and with harmonious settings; there are occasional business blocks whose treatment is satisfactory, but very few public buildings that have an adequate artistic meaning and are so situated as to express

this advantageously if they did possess it. Without detracting in the least from the acknowledged merits of the design of Trinity Church, Boston, it must be admitted that its roomy location on one side of an open plaza adds greatly to its effectiveness. Think of its being placed in the middle of a block on Washington Street, or set in the midst of brown stone fronts on Fifth Avenue! All public buildings need both room and appropriate setting. They are the larger and more important pictures in the gallery of city structures; yet under the prevailing system of rectangular blocks, bounded by long, straight, and narrow streets, the hanging committee has nothing but the walls of corridors on which to place them. The worst of the matter is that the exhibition is a permanent one. Along these alleyways must also be hung the narrow, vertically elongated panels that seem to be so popular to-day, in favor because they pay. The observer needs a twenty-story ladder in order to study their details, or even to know if they have any, and can find no point from which they may be seen as entireties. At their sides hang strings of pictures whose horizontality exaggerates their skyward tendency. It is not the modern tall building in itself that is here objected to, but its location on sites that will not admit of a display of its best qualities. With wide, clear spaces about them and effective grouping they may be made agreeable, as is illustrated by the happy combination at the southeast corner of Central Park.

One of the good results of the tall building craze is the bringing closer together of two branches of designers; from the architect the engineer will learn more of art, and he will teach the former better construction. While retaining their separate functions, the collaboration will result in a higher mutual respect and appreciation, and a better grade of work on the part of each.

It is undisputed that the rectangular plans of American cities are neither adapted to meet æsthetic conditions nor the demands of traffic. The long streets, without variation in width and direction, and without the breaks afforded by little parks, are tiresome to the eye. They are not placed with any regard for the topography or the natural features of the landscape, or to give prominence to some important structure, nor do they furnish direct lines of travel. But the plan is weighted down to the ground by millions of money. So it is not a question of what it

ought to be, but one of mitigating the present evils and avoiding any repetition of these in the future.

Radical treatment must be resorted to by way of diagonal avenues from congested centres, and the widening out of the intersections of important streets into parks and plazas. There must likewise be an heroic struggle with the water fronts and internal watercourses, places full of picturesque possibilities, though usually given over to filth and ugliness. These changes are made imperative not only by æsthetic requirements, but also by the demands of health and business.

In the planning of additions to large cities, the designer is hampered by the supposed necessity of tying to the older plan, by the desire of owners and speculators to realize to the largest extent on the sale of lots, or by his uncertainty as to what the future growth and character of the population may be. An examination of the block plan of many of our cities would show a heterogeneous arrangement of streets, especially in outlying districts, without regard to mutual relations, matters of grade and drainage, or artistic position. This irregularity may be more inconvenient and less pleasing than a right-angled plan. Our towns and smaller cities reproduce in miniature the conditions of the larger centres. Here again it is a question of improvement, instead of original design, only the problems involved are not so intricate and their solution not so costly. So it is hardly possible for a designer to plan an ideal city, or to have the full swing and liberty of the men who laid out the city of Washington and established its system of grades and drainage. But in spite of difficulties there exist some suburban districts, laid out, built up, and adorned on the principles of good taste. Thanks to the systems of rapid transit that are increasing the number of these attractive places!

In the design and maintenance of water supply plants, American practice shows some respect for the artistic element. This is not confined to any particular system or any part of any one plant, but is quite general. The engine-houses are not ugly, and their interiors are often attractive. Gate-houses, aqueducts, and dams are decoratively treated, and form pleasing features in the landscape. The slopes of reservoirs are kept trim, and the grounds generally turned into lawns with flower beds, and perhaps a fountain. No doubt the sanitary conditions imposed

have had much to do with this, but the result is none the less in good taste. We cannot avoid, however, a stray shot at the ugly standpipe, with conical cap, sometimes seen in our smaller towns. This is unnecessary. When enclosed it has been made an interesting object, and even the bare pipe can be ornamented in such a way as to relieve its nakedness.

There is much encouragement in the growing appreciation and enjoyment of public parks and boulevards. Cities and towns all over the land are trying to beautify what they already have, and are adding new territory to their park resources. Admirable skill has been shown in utilizing the natural features of the local landscape, the rocks, tree masses, meadows, ravines, ponds, and streams, the wide expanse of ocean or glimpses of bright water. The curving roads and paths, with undulating gradients, have a beauty of their own, and lead one from point to point of the ever changing scene, and yet bind it all into one harmonious whole. While the landscape engineer deserves credit, not so much praise can be given park commissioners for the artificial adornments which they have added to his work. Notwithstanding the fact that these are sometimes labelled as artistic, they do not always fit in appropriately.

The writer firmly believes that there is a latent æsthetic quality in American life that is now struggling to find both means for its gratification and methods of expression. Before there can be knowledge of its meaning and power there must be many attempts and many failures. The whole process is one of education, and that largely in the school of experience. This applies to the industrial and constructive arts, as well as to the fine arts. The engineer will share in the general movement, but this is not enough. As a designer of so much that the world needs for daily use, he must do more than keep up, he must keep in advance. He must not only have a capacity to enjoy, but also the power to originate and apply. To this end he must give preliminary study and thought to the principles of æsthetic design, so gaining an intellectual knowledge of them. American engineering schools are doing little or nothing to help the young engineer to this. So far as the writer knows, there is but one American text-book, Professor Johnson's book on bridges, that includes any discussion of the matter. A course of study in engineering æsthetics near the close of college life would be a great help and

stimulus to a young graduate, at least opening his eyes to the fact that there was such a thing. After knowledge comes the application of principles as tests to an engineer's own work and to that of other men. And, finally, with theoretical and practical knowledge well in hand, and a love of what is beautiful, comes the impulse to work artistically. With such engineers and an appreciative clientele American engineering would be artistic. To this end let us work.

PAPERS READ.

Beginning Tuesday, August 25.

STEAM ENGINEERING.

The most economical points of cut-off for steam. By Prof. Henry T. Eddy, University of Minnesota, Minneapolis. (Published in *The Electrical World*, Sept. 26, 1896.)

The performance of small steam pumps. By Prof. M. E. Cooley, University of Michigan, Ann Arbor, Mich.

The friction of the water in the pipes of a hot water heating system. By Prof. J. H. Kinealy, Washington University, St. Louis, Mo.

On a continuous indicator for engine tests. By Prof. Thomas Gray, Rose Polytechnic Inst., Terre Haute, Ind.

New water prony brake for testing steam turbines without reduction gearing. By Prof. J. E. Denton, Stevens Institute, Hoboken, N. J. (Published in *Power.*)

Apparatus for tracing a curve representing the force required to overcome the inertia of the reciprocating parts of a steam engine. By Prof. D. S. Jacobus, Stevens Institute, Hoboken, N. J. (Published in *Power.*)

An apparatus for accurately measuring pressures of 2,000 pounds per square inch and over. By Prof. D. S. Jacobus, Stevens Institute, Hoboken, N. J. (Published in *Power.*)

Apparatus for exhibiting the distribution of moisture in a steam main. By Prof. D. S. Jacobus, Stevens Institute, Hoboken, N. J. (Published in *Power.*)

Values of heat of combustion of various gases per cubic foot for use in calculating the heating power from the analysis of a gas. By Prof. D. S. Jacobus, Stevens Institute, Hoboken, N. J. (Published in *Power.*)

MECHANICS AND MATERIALS.

On the molecular stability of metals. By Prof. Wm. A. Rogers, Colby University, Waterville, Me.

A new testing machine for beams and framed structures (capacity 50 tons). By Prof. Malverd A. Howe, Rose Polytechnic Inst., Terre Haute, Ind.

On the yield point of steel. By Prof. Thomas Gray, Rose Polytechnic Inst., Terre Haute, Ind.

On the conversion of an ordinary planer into an apparatus for precise graduations. By Prof. Wm. A. Rogers, Colby University, Waterville, Me.

HYDRAULIC ENGINEERING.

The hydrographic survey. By Prof. F. H. Newell, U. S. Geological Survey, Washington, D. C.

Some notes, physical and commercial, upon the delta of the Mississippi river. By Elmer L. Corthell, C. E., New York City.

(This paper was printed for private distribution by the author. Copies can be had on application to Elmer L. Corthell, C. E., 71 Broadway, New York City.)

MISCELLANEOUS.

An arrangement using storage batteries for the automatic regulation of engine loads in power plants of variable output. By Prof. W. S. Franklin, Iowa State College, Ames, Iowa. (Published in *The Electrical World*.)

The cycle of the plunger-jig. By Prof. R. H. Richards, Mass. Inst. of Technology, Boston. (To be published in *Transactions* of the American Inst. of Mining Engineers.)

Soaring flight. By O. Chanute, Chicago, Ill.

The Section adjourned Thursday noon, August 27.

SECTION E.

GEOLOGY AND GEOGRAPHY.

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ADDRESS

BY

VICE-PRESIDENT

B. K. EMERSON,

CHAIRMAN OF SECTION E.

GEOLOGICAL MYTHS.

MANY years ago I visited the British flagship "Bellerophon" in the harbor of Bermuda, and was told that when the ship was first named the sailors wrestled with the sonorous but unmeaning name, and quickly transformed it into "Billy-ruffian," and it became at once intelligible, and belligerent, and satisfying.

There arose, however, a contest in the forecastle as to whether "Billy-ruffian" or "Bully-ruffian" was the correct thing, — certain rude fellows of the baser sort wishing to have the word pugnacious in both its proximal and distal extremities.

This illustrates the principle of attraction in language whereby words without meaning to the users tend to be modified into forms which at least appear intelligible.

It is said that when asparagus was introduced into England the peasants immediately called it "sparrow-grass," and went on to explain that the reason it was called sparrow-grass was because the sparrows ate the red berries.

This illustrates the second step of the process. The word is first attracted into a form which has a meaning, and in its turn this meaning requires a justification, and this the meaning itself quickly suggests.

The peasant was not disturbed by, or did not observe, the fact that the sparrows do not eat the red berries. This would have been to have risen to the "verification of hypothesis," — an indefensible encroachment on the terrain of the British philosopher.

I propose to trace the history of several myths which have their origin in remarkable geological phenomena, for I hardly need to say that I do not use the word myth in the modern fashion of newspaper English, as a false report, a canard, in short, a newspaper story; but as meaning a history, treasured and hallowed in the literary and religious archives of an ancient folk, of some startling or impressive event, that, in the stimulating environment of poetry and personification, has completed a long evolution, which disguises entirely its original, —

> "Has suffered a sea-change
> Into something new and strange,"

so that, in fact, its study is paleontological.

I propose to speak of the Chimæra, or the poetry of petroleum, of the Niobe, or the tragic side of calcareous tufa, of Lot's wife, or the indirect effect of cliff erosion, and of Noah's flood, or the possibilities of the cyclone and the earthquake wave working in harmony.

THE CHIMÆRA.

The myth of the Chimæra is told, in its earliest form, in a quaint old translation of Hesiod, who, according to the Marbles of Paros, lived about nine centuries before the Christian Era.

> "From the same parents sprang Chimæra dire,
> From whose black nostrils issued flames of fire;
> Strong and of size immense; a monster she
> Rapid in flight, astonishing to see;
> A lion's head on her large shoulders grew,
> The goats and dragons terrible to view;
> A lion she before in mane and throat,
> Behind a dragon, in the midst a goat;
> Her Pegasus the swift subdued in flight
> Backed by Bellerophon, a gallant knight,
> From Orthus and Chimæra, foul embrace,
> Is Sphinx derived, a monster to the race."

The same story is told a little later by Homer[1] with more grace of diction.

> "And Glaucus in his turn begot
> Bellerophon, on whom the gods bestowed
> The gifts of beauty and of manly grace.

[1] Iliad, VI. 180; Earl Derby's Translation, VI., 184–216.

But Prœtus sought his death; and mightier far,
From all the coasts of Argos drove him forth.
. . . .
To Lycia, guarded by the gods, he went;
But when he came to Lycia and the stream
Of Xanthus, there with hospitable rites
The king of wide-spread Lycia welcomed him.
Nine days he feasted him, nine oxen slew;
But with the tenth return of rosy morn
He questioned him and for the tokens asked
He from his son-in-law, from Prœtus bore
The token's fatal import understood,
He bade him first the dread Chimæra slay,
A monster sent from heav'n — not human born,
With head of lion and a serpent's tail,
And body of a goat, and from her mouth
There issued flames of fiercely-burning fire.
Yet her, confiding in the gods, he slew.
Next with the valiant Solymi, he fought
The fiercest fight he ever undertook,
Thirdly the women-warriors he overthrew,
The Amazons."

It will be seen here that Bellerophon, like Hercules or St. George, is a professional wandering slayer of dragons. His name from βάλλω, the far-throwing rays of the sun, shows him to be a type of the wide-spread sun-myth, whose rising rays strike down the forms of darkness.

But the myth of Chimæra is independent of him, and is always localized; there is always the tail of a dragon, the body of a goat, and the head of a lion, or the three heads of lion, goat, and serpent, and it vomits fire, and ravages in the mountains of woody Lycia.

The classical prose-writers describe the phenomenon with curious accuracy. Seneca says: —

"In Lycia regio notissima est.
Ephestion incolæ vocant,
Perforatum pluribus locis solum,
Quod sine ullo nascentium damno ignis innoxius circuit.
Læta itaque regio est et herbida nil flammis adurentibus."

(In Lycia is a remarkable region, which the inhabitants call Ephestion.[1] The ground is perforated in many places; a fire plays harmlessly without any injury to growing things. It is a

[1] That is, Vulcan.

pleasant region, therefore, and woody, nothing being injured by the flames.)

Strabo says, simply: "The neighborhood of these mountains is the scene of the fable of the Chimæra, and at no great distance is Chimæra, a sort of ravine, which extends upward from the shore." And Pliny, with his accustomed mingling of truth and fiction, says: "— et ipsa (Chimæra) sæpe flagrantibus jugis" (and Chimæra itself with its flaming peaks). And again: "Flagrat in Phaselide Mons Chimæra et quidem immortali diebus ac noctibus flammâ." (Mount Chimæra burns in Phaselis with a certain immortal flame shining by day and by night.) Also: "In the same country of Syria the mountains of Hephæstius, when touched with a flaming torch, burn so violently that even the stones in the river and the sand burn while actually in the water. This fire is also increased by rain. If a person make furrows in the ground with a stick which has been kindled at this fire, it is said that a stream of flame will follow it."

Servius, the ancient commentator of Virgil, explains the myth as follows: "The flames issue from the summit of the mountain, and there are lions in the region under the peak, the middle parts of the hill abound with goats, and the lower with serpents." While the modern commentators say: "The origin of this fire-breathing monster must be sought probably in the volcano of the name of Chimæra in Phaselis in Lycia,"[1] and the myth did not escape the great, but largely wasted, erudition of Knight, who says: "In the gallery in Florence is a colossal image of the Phallus, mounted on the back parts of a lion, and hung round with various animals. By this is represented the co-operation of the creating and destroying powers, which are both blended and united in one figure, because both are derived from one cause. The animals hung round show also that both act to the same purpose, that of replenishing the earth, and peopling it with still rising generations of sensitive beings. The Chimæra of Homer, of which the commentators have given so many whimsical interpretations, was a symbol of the same kind, which the poet, probably having seen in Asia, and not knowing its meaning (which was only revealed to the initiated), supposed to be a monster that had once infested the country. He described it as

[1] Smith's Dict. of Clas. Antiq., sub Chimæra.

composed of the forms of the goat, the lion, and the serpent, and breathing fire from its mouth (Il. VI. 182). These are the symbols of the creator, the destroyer and the preserver, united, and animated by the fire, the divine essence of all three.

"On a gem published in the Memoirs of the Academy of Cortona this union of the destroying and preserving attributes is represented by the united forms of the lion and the serpent crowned with rays, the emblems of the cause from which both proceed. This composition forms the Chnoubis of the Egyptians."[1]

And thus the matter rested until, in the end of the last century, Admiral Beaufort,[2] while anchored off Lycia on hydrographic work, saw each night a strong flame on the peak of a mountain a few miles back from the coast, and was told by the inhabitants that it had always burned there.

He visited the place, and found flames of natural gas issuing from a crevice on a mountain of serpentine and limestone.

In 1842, Spratt and Forbes[3] report, as follows, on the locality: Near Ardrachan, not far from the ruins of Olympus, a number of serpentine hills rise among the limestones, and some of them bear up masses of that rock. At the junction of one of these masses of scaglia with the serpentine is the Yanar (or Yanar-dagh), famous as the Chimæra of the ancients, rediscovered in modern times by Captain Beaufort. It is nothing more than a stream of inflammable gas issuing from a crevice, such as is seen in several places among the Apennines. The serpentine immediately around the flame is burned and ashy, but this is only for a foot or two, — the immediate neighborhood of the Yanar presenting the same aspect it wore in the days of Seneca, who writes, "Læta itaque regio est et herbida, nil flammis adurentibus."

Such is the Chimæra, "flammisque armata Chimæra,"[4] deprived of all its terrors. It is still, however, visited as a lion by both Greeks and Turks, who make use of its classic flames to cook kabobs for their dinner.

In 1854 it was visited by the Prussian painter, Berg, who has reproduced the scene in a fine painting now in Berlin.[5] The flame

1 Richard Payne Knight. Discourse on the Worship of Priapus, p. 73.
2 Beaufort's Karamania, 35, 52, 85.
3 Travels in Lycia, II. 181, 1847.
4 Virgil, Æneid, VI. 288.
5 Zeitschrift, All. Erdkunde, III. 307.

which, he says, gives the odor of iodine, is three or four feet high. Several extinct openings were found in a pool of sulphurous water.

The Austrian geologist, Tietze,[1] found the flame two feet across, and a smaller one adjacent. The ruins of an ancient temple of Vulcan, near by and of a late Byzantine church, show how strongly it has impressed the inhabitants in all ages.[2]

The natural phenomenon of a spring which is found by historic documents to have been burning for nearly three thousand years is sufficiently striking, although the slow escape of such gas from tertiary limestones is not uncommon. The mention of sulphurous waters in the neighborhood may justify us in going back to the same antiquity and drawing from the remark of Theophrastus (Περὶ τῶν λίθων) on the oxidation of pyrite in contact with bitumen, an explanation of the constant ignition of the gas.

Theophrastus says: "That, also, which is called Epinus (or Spelus) is found in mines. This stone cut in pieces and thrown together in a heap exposed to the sun, burns, and that the more if it be moistened or sprinkled with water."

We may of course assume the more prosaic spontaneous combustion of the volatile hydrocarbons to explain the constant rekindling of the sacred fires.

It remains to consider how the myth and its name arose. The mountain is still called Yanar-dagh, the burning mountain, and in a learned work on coins of Sicyon, which reproduce the Chimæra, M. Streber derives the name from the Phœnician word Chamirah, which means the burning mountain.

But the Greek word χαμαίρα means a goat, and has almost the same sound, and we can see clearly how, as the Greek settlements spread over Lycia, from the north, the meaningless Phœnician names were retained like the Indian names in America, and how the story slowly went back to the fatherland — et crescit eundo — of a strange mountain called Chamira, from which portentous flames escaped, and then of a monster Chimæra, of goat-like form, vomiting flames and ravaging in the mountains of woody Lycia. And so the story was finally fitted for the manipulation of the poets, who little thought they were making the stout Bellerophon run a quixotic tilt against a burning gas well.

[1] Beitrage zur Geologie Lykien. Jahrbuch d. K. K. Geol. Reichsanstalt, XXXV. 353.

[2] C. Ritter, Erdkunde, Theil 19, 751.

THE NIOBE.

Like the Chimæra, the Niobe is an episode in Greek Mythology, easily separated from the rest without disturbing the Greek Pantheon. I do not need to describe the great group of the Niobe, the mother weeping over her children, who fall before the shafts of Apollo, which adorns the gallery of the Uffizi at Florence, and forms one of the masterpieces of Greek sculpture, the glory of Scopas or Praxiteles. I do not need to recall the story as told by Homer, how Niobe, the daughter of Tantalus, proud of her twelve children, despised Latona, who had but two; how, therefore, Phœbus and Artemis slew all the twelve with their arrows: —

"They lay unburied on the plain for nine days, when Zeus changed them to stone, and on the tenth day the heavenly gods buried them. And now, upon arid Sipylus, upon the rocks of the desert mountain, where, they say, are the couches of the divine nymphs, who dance upon the banks of Achelous, Niobe, though turned to stone, still broods over the sorrow the gods have sent upon her."

And Ovid says: —

> "She weeps still, and borne by the hurricane of a mighty wind,
> She is swept to her home, there fastened to the cliff of the mount,
> She weeps, and the marble sheds tears yet even now."

As one climbs from the Gulf of Smyrna, between Mount Tmolus and Sipylus, up the rich valley of the Nif, or Nymphio, there appears, high up in the vertical wall of limestone, the colossal bust of a woman standing on a high pedestal and in a deep alcove. It is cut out of the living rock, like the Swiss lion at Lucerne.

A recess twenty-five feet high and sixteen feet wide has been cut in the rock for the lower part, and a smaller alcove of much greater depth surrounds the bust itself. All the face of the rock around is smoothed, and a broad ledge is cut around the pedestal to receive the offerings of the ancient Phœnician worshippers of this almost prehistoric statue of the great Mother Cybele, or of Meter Sipylene; gods of the Phœnicians.

From the valley below it makes the impression of a full-length statue with flowing robes, but near at hand the robes are seen to

be the very tears of Niobe, formed where the drip of the waters from the limestone roof of the alcove has first struck her cheeks, and running down across her breast has made rippling surfaces of bluish tufa, which has all the effect of tears.

The statue had been greatly corroded, and the stalagmite tears had formed already in the days of Pausanias, who says: "When standing close to it the rocks and precipice do not show to the beholder the form of a woman, weeping or otherwise, but if you stand farther back, you think you see a woman weeping and sad."

And even in the times of Homer the memory of the earlier and vanished worshippers was at best a dim tradition, and the facile imagination of the Greeks had built up the whole beautiful legend, every element of the surrounding scenery adding its portion of suggestion, and it is marvellous how all parts of the story still linger in the valley.

As the grand missionary, artist, and geologist, van Lennep, from whom I have obtained most of this account,[1] who in all his travels in Asia Minor collected carefully, and labelled carefully, and sent valuable material to his Alma Mater, Amherst, was climbing to the statue, his guide, a cake-seller by the roadside, said: "There is a tradition that this statue was once a woman, whose children were killed, and she wept so that God changed her to stone. They say that her tears make a pond down there, and still keep it full."

All the people of the region, ignorant and learned, agree in this, while all travellers have called this the statue of Cybele.

Their name for the valley, Nif, is a corruption of Nymphio, as Homer says, "the couches of the divine nymphs." Sipylus, the name of the mountain to this day, was also the name of the oldest son of Niobe.

Niobe was the daughter of Tantalus. Tantalus, from ταλαντεύω, to balance, is a rock poised in the air, an allusion to the ledges overhanging the statue, and threatening to fall and crush it.

That she is the mother of many children may be a reminiscence from Cybele, the All-mother, and the mention of the couches of the divine nymphs seems to suggest some ancient nature worship of the valley. The children slain by the arrows of Phœbus are the masses of rock dislodged from the cliffs around her by the

[1] Asia Minor, II. 300. London, John Murray, 1870.

action of sun and rain, and forming the great talus at the foot of the bluff.

"They lie unburied on the plain," Homer tells us, "till on the tenth day the heavenly gods bury them," as the fallen rock quickly disintegrates under the influence of the weather in this warm climate. The Greek word, Niobe, connects itself with the pouring of water and the falling of snow (νίζω, νίπτω, and νίφω), so a Greek impersonation of the drip from the marble cliff upon the ancient rock sculpture might easily have acquired the name of Niobe, the weeping one.

"It seems, thus," says van Lennep, "that this sculpture was executed in a very remote antiquity, to represent Cybele, the mother of the gods, or some form of nature-worship, that the water drip from the rock above gave it, from the first, the same striking watermark which it still bears, maintained by the same cause, and that this appearance suggested to the lively imagination of the Greek the whole myth of Niobe, — her tears, her sorrows, her strange transformation, her perpetual weeping; so this most ancient statue is not an image sculptured to represent this story of Niobe, but is itself the very original from which the story sprung." It is thus an impressive testimonial of the vast importance of the loose bond by which the second molecule of CO_2 is held combined in calcic bicarbonate.

LOT'S WIFE.

Looking down on that most marvellous of all lakes, — the Dead Sea, the Lacus Asphaltites of the Romans, — the sea of Lot of the Arabs, still stands the great column of salt into which Lot's wife was changed.

"She was changed into a pillar of salt," says Josephus, "for I have seen it, and it remains to this day."

And Irenæus explains how it came to last so long with all its members entire, because "when one was dissolved it was renewed by miracle." It was, in fact, the geological miracle of erosion.

The column looks down from the plain of Sodom, and on the great southern bay of the sea, ten miles square, and but one or two feet deep, where sulphur, deposited by many hot springs, is abundant in the clay, and where bitumen oozes from every crevice of the rock, and every earthquake dislodges great sheets

of it from the bottom of the lake, where the Arabs still dig pits for the "stone of Moses" to gather in, and sell it in Jerusalem, and where, in that most ancient fragment of the Pentateuch, four kings fought against five, and the kings of Sodom and Gomorrah slipped in the slime-pits and fell. One who has read of the burning of an oil well or oil creek, or in Apscheron will have a clear idea of the catastrophe which overtook the cities of the plain where the Lord rained upon Sodom and upon Gomorrah brimstone and fire out of heaven.

Following the latest extremely interesting researches of Blankenkorn,[1] we may picture the upper cretaceous plateau of Judea, — an old land, cleft at the end of the Tertiary by many faults, between which a great block sank to form the bottom of this deep sea. It carried down in the fossiliferous and gypsum-bearing beds the source of the bitumen and the sulphur. We may picture the waters standing much higher than now during the pluvial period, which matched the northern glacial period, rising nearly to the level of the Red Sea, but never joining it. In the succeeding arid interglacial period, the time of the steppe fauna in Europe, the sea shrank to within a hundred meters of its present level, and deposited the great bed of rock-salt which underlies the low plateaus around its southern end. The advent of the second glacial period was here the advent of a second pluvial period, which swelled the waters and carried the bitumen-cemented conglomerates over the salt-beds to complete the low plateau. After a second arid period with some lava flows, and a third pluvial period with the formation of a lower and broader terrace, the waters shrank to the present saturated bitterns in the present arid period. In the earlier portion of this last or post-glacial stadium, a final sinking of a fraction of the bottom of the trough, near the south end of the lake, dissected the low salt plateau, sinking its central parts beneath the salt waters, while fragments remain buttressed against the great walls of the trench forming the plains of Djebel Usdum and the peninsula El Lisan, with the swampy Sebcha between. Imagine a central portion of one of the low plains which extend south from the "Finger Lakes" to sink, submerging Ithaca or Havana in a shallow extension of the lake waters. It exposed the wonderful eastern wall of

[1] Dr. Max Blankenkorn, Entstehung und Geschichte des Todten Meers. Zeit. Deutsch. Palestina-Vereins, vol. xix. p. 1, 1896.

Djebel Usdum: seven miles long, with 30 — 45 m. of clear blue salt at the base, capped by 125 — 140 m. of gypsum-bearing marls impregnated with sulphur, and conglomerates at times cemented by bitumen. It was this or some similar and later sinking of the ground, at the time when geology and history join, which, with its earthquakes, overthrew the cities of the plain and caused the outpour of petroleum from the many fault fissures and the escape of great volumes of sulphurous and gaseous emanations, which, ignited either spontaneously, by lightning, or by chance, furnished the brimstone and fire from heaven, and the smoke of the land going up as the smoke of a furnace which Abraham saw from the plains of Judea.

But with Lot's wife the case is different. The bed of salt out of which she was carved, and has been many times carved, was exposed by the very catastrophe which destroyed the cities; and Lot fled to Zoar in a direction opposite to that in which the salt bed lies. As Oscar Fraas found his Arabs calling the salt pyramid "Lot's column," so, in early times, when the tradition of the burning cities was gradually growing into the myth of Sodom, and of Lot, some old name of the salt column, grown meaningless, may have had such sound as to suggest the term, "Lot's wife," — Bint Sheck Lut, or the woman's own name in the current language, as Chamirah, the burning mountain, suggested Chimæra, the goat, and the answer to the question why was the salt column called Lot's wife was quickly given and woven into the legend. In that dry climate successive erosions have reproduced it along the seven-mile ridge of salt, still called Kashum Usdum or Sodom.

THE FLOOD.

Only through an exegesis of the German words Alluvium and Diluvium would the young geologist be reminded of the time when the Flood was a burning question in geology, an igneo-aqueous question, so to speak, — when commentaries explained the fossil shells in the Appenines as due to Noah's Flood, and Voltaire tried to break the force of this important proof of the truth of the Bible by declaring these shells to be the scallop-shells thrown away by expiring pilgrims of the Crusades; — when Andreas Scheuzer apostrophized his fossil salamander ("Homo diluvii testis et theoscopos"): —

"Betrübtes Beingerüst von einem alten Sünder
Erweiche Stein und Herz der neuen Bösheits-kinder."

This ancient sinner's scattered and dishonored bones
Should touch the stony hearts of modern wicked ones.

It was thus a great surprise when one of the most powerful and philosophical works of the century on Geology, "Das Antlitz der Erde" of Suess, had as its opening chapter an explanation of the Flood as due to a coincidence of a cyclone and an earthquake at the mouth of the Euphrates. The Biblical account is plainly exotic, told by a people ignorant of sea-faring, — a fresh-water account of a salt-water episode. The description of the vessel as a box or ark, the going in and shutting the doors, and the opening of the windows remind one of a house-boat, and indicate the adaptation of the story to the comprehension of an inland people. Its minor discrepancies and blending of the Jahvistic and Elohistic elements show the story has come by devious courses from a distant source.

The account of the Chaldean priest, Berosus, 250 B. C., located the occurrence at the mouth of the Euphrates, where the native boatman still pitches his boat within and without with pitch, as the ark was pitched.

Berosus, priest of Bel, quoted by Alexander Polyhistor, says that the Flood occurred under the reign of Xisuthros, son of Otiartes. Kronos announces to Xisuthros, in a dream, that on the fifteenth of the month Daisios all mankind shall be destroyed by a flood. He commands him to bury the writings containing the records of the history of his country at Sippara, city of the dead, then to build a vessel, to stock it with provisions, then to embark with his family and his friends, also to take quadrupeds and birds with him.

Xisuthros obeys the command. The Flood occurs, and covers the land, it decreases, he lets out birds to gain knowledge of the state of things, and finally leaves the ship, and prepares, with his family, an offering to the gods. Xisuthros is then, for his piety, translated to live among the gods, with his wife, his daughter, and the steersman. Of the ship of Xisuthros, which finally stranded in Armenia, there still remains a portion in the Cordyaian Mountains in Armenia, and the people scrape off the bitumen with which it is covered, and use it as an amulet against sickness. And as the others had returned to Babylon and had found the

writings at Sippara, they built towns and erected temples, and so Babylon was again peopled.

Twenty years ago George Smith excavated and translated the inscribed tiles of the library of Asurbanipal, King of Assyria, 670 B. C., who, at the time of the founding of Greece, was gathering copies of the sacred writings of the ancient cities of Asia. The historical books of this library carry the annals of the Babylonians back 3800 B. C., but contain no certain account of any flood. How remote must then have been the great catastrophe which had filtered down in tradition and become embalmed in sacred myth and stately poem before the dawn of history! I present here, after the latest translations of Haupt and Jensen,[1] the last but one of the cantos of the Gilgamos Epic, corresponding to the eleventh sign of the zodiac, Aquarius (or month of the curse of rain), containing the story of the Flood.

Gilgamos (= Nimrod), the hero of Urruh, leaves his native town sick and troubled by the death of his friend Eabani, and visits his ancestor Samasnapisthim (= Xisuthros) called Hasisadra (= the devout wise man). Hasisadra spoke to him, to Gilgamos, "I will make known unto thee, O Gilgamos, the hidden story, and the oracle of the gods I will reveal to thee. The city of Shuripak, — the city which, as thou knowest, lies on the bank of the river Euphrates, — this city was already of high antiquity when the gods within set their hearts to bring on a flood storm (or deluge). Even the great gods who were there, — their Father Anu, their councillor, the warlike Bel, their throne-bearer, Adar, their prince, Ennugi. But the Lord of unfathomable wisdom, the god Ea (the god of the sea), sat alone with them in council, and announced their intention unto the field, saying, Field! Field! town! town! field! hear! town; give attention, O man of Shurippak, son of Ubara-Tutu (The splendor of the Sunset, Lenarmont, Sayce). Destroy thy house, build a ship, save all living beings which thou canst find. Withdraw from what is doomed to destruction. Save thy life, and bid the seed of life of every kind mount into the ship.

"The vessel which thou shalt build, 600 half cubits in length, shall be her shape, and 120 half cubits the dimensions for both

[1] Haupt: in Das Ansicht der Erde. The first part from a later translation; Johns Hopkins Circulars (VIII. No. 69, p. 17), P. Jensen in Dr. Carl Schmidt, Das Naturereignis der Süpdflut.

her width and depth. Into the sea launch her. When I understood this, I spake unto the god Ea, — My lord, thy command which thou hast thus commanded, I will regard it. I will perform it, but what shall I answer the city, the people, the elders? (The young men and the elders would ridicule me.)

"The god Ea opened his mouth and spake unto me, his servant: 'And thou shalt thus say unto them, "I know the god Bel (the god of Shuripak) is hostile to me, so I cannot remain in (the city); on Bel's ground I will not rest my head. I will sail into the deep sea; with the god Ea my lord I will dwell." But upon you there will pour down a mass of water. Men, fowl, and beast will perish, the fish only will escape. . . . And when the sun will bring on the appointed time Kukki will say, "In the evening the heavens will pour down upon you destruction."

"'Then, however, close not thy door until the time comes that I send thee tidings. Then enter through the door of the ship, and bring into its interior thy food, thy wealth, thy family, thy slaves, thy maidservants and thy kindred. The cattle of the field, the wild beast of the plains . . . will I send you, that thy gates may preserve them all.'

"Hasisadra opened his mouth and spake. He said to Ea his lord: 'No one has ever built a ship in this wise on the land. However, I will see to it, and build the ship upon the land, as thou hast commanded.' (The description of the building of the vessel very partial.) I built the ship in six stories. I saw the fissures, and added that which was lacking. Three sars of bitumen I poured upon the outside, three sars of bitumen I poured upon the inside. (Thirteen lines of description illegible.) The vessel was finished. All that I had I brought together, all that I had in silver I brought together. All that I had of gold I brought together. All that I had in living seed I brought together. And I brought all this up into the ship, all my manservants and my maidservants, the cattle of the field, the wild beast of the plain, and all my kindred, I bade embark.

"As now the sun had brought on the appointed time, a voice spake: 'In the evening the heavens will rain destruction. Enter into the interior of the ship and shut the door. The appointed time is come.' The voice said, 'In the evening the heavens will rain destruction.' With dread I looked forward to the going down of the sun. On the day appointed for embarking I feared

(greatly). Yet I entered into the interior of the ship and shut to my door behind me to close the ship. To Buzurbil, the steersman, I gave over the great structure with its load. Then arose Museri-ina-namari from the foundations of the heavens, — a black cloud, in whose middle Ramman (the weather-god) let his thunder roar, while Neba and Sarru rush at each other in warfare.

"The Throne-bearers stalk over mountain and land,
The mighty god of pestilence let loose the whirlwinds (?)
Adar lets the canals overflow unceasingly.
The Anunnaki raise their torches,
They make the earth glow with their radiant gleams.
Ramman's inundating wave rises up to heaven,
All light sinks in darkness.
In a day they lay waste the earth like a plague, the winds raging blow.
Mountain high they bring the waters to fight against mankind.
The brother sees the brother no more,
Men care no more for one another.
In heaven the gods fear the deluge and seek refuge.
They mount up to the heavens of the god Anu.
Like a dog in its lair the gods crouch at the windows of heaven.
Istar (the mother of mankind) cries like a woman in childbirth,
The sweet-voiced queen of the gods cries with loud voice:
'The dwelling place of mankind is reduced to slime.
That has come which I announced before the gods as an approaching evil.
I have announced the evil before the gods, —
The war of destruction against my children have I announced.
That which I brought forth, where is it. It fills the sea like fish-spawn.'
Then the Gods wept with her over the doings of the Anunnaki.
They pressed their lips together."

"Six days and six nights the wind and the deluge and the storm prevailed. At the opening of the seventh day, however, the storm lessened, the hurricane, which had waged a warfare like a mighty army, was appeased, and storm and deluge ceased. I sailed the sea mourning that the dwelling-places of mankind were changed to slime. Like logs the bodies floated around. I had opened a

window, and as the light of day fell upon my face I shuddered and sat down weeping. My tears flowed over my face. Wherever I looked was a fearful sea. In all directions there was no land. Helpless the ship drifted into the region of Nizir. There a mountain in the land of Nizir held the ship stranded, and did not allow it to advance farther toward the heights. On the first and second day the mountain of Nizir held the ship. Also on the third and the fourth day the mountain of Nizir held the ship. Even so on the fifth and the sixth day the mountain of Nizir held the ship. At the approach of the seventh day I loosened a dove and caused it to go forth. The dove went, it turned, and it found not a place where to rest, and it returned. I loosened and I caused to go forth a swallow. It went, it turned, and it found not a place where to rest, and it returned. I loosened and I caused to go forth a raven. The raven flew off, and as it saw that the water had fallen it turned back. It waded in the water, but it returned not.

"Then I caused all to go forth to the four winds, and made a sacrifice. I erected an altar on the peak of the mountain. I disposed of the measured vases, seven by seven; beneath them I spread seeds, — cedar and juniper. The gods smelled the odor. The gods smelled the good odor. The gods gathered like flies above the master of the sacrifice. From afar then the goddess Istar at her approach raised the great bows that Anu has made as their glory. She said, 'By the ornaments of my neck never will I forget. These days will I remember and never will I forget them forever. May the gods come to my altar. Bel shall never come to my altar because he has not controlled himself, and because he made the deluge, and my people he has given over to destruction.'

"Bel also, at his approach, saw the vessel from afar. Bel stood still; he was full of anger against the gods and the godlike ones.

"What soul has then escaped?

" Never shall man survive the destruction.

"Adar opened his mouth and he spake. He said to the warrior Bel: —

" 'Who, also, if it be not Ea, can have planned this? And Ea knew and has informed him.' Ea opened his mouth and spake. He said to the warrior Bel: 'Thou herald of the gods, warrior,

why hast thou not controlled thyself; why hast thou made the deluge? Visit upon the sinner his sin, upon the blasphemer his blasphemy. Be persuaded not to destroy him. Be merciful that he be not destroyed. Instead that thou shouldst make a deluge, let the lions come, and let them cut off men. Instead that thou shouldst make a deluge, let the hyenas come, and let them devour men. Instead that thou shouldst make a deluge, let the famine come and destroy the land. Instead that thou shouldst make the deluge, let the god of pestilence come and destroy the land. I have not disclosed the decision of the great gods. Hasisadra has interpreted a dream, and has understood the decision of the gods.' Then Bel came to a better mind. He mounted to the interior of the vessel, he took my hand and made me to rise; myself made he to rise. He made my wife to stand up, and put her hand in mine; he turned around to us and blessed us.

"'Hitherto Hasisadra was mortal, and behold, now, Hasisadra and his wife are lifted up to the gods. He shall dwell far away at the mouths of the rivers.'

"They took me, and in a secluded place at the mouths of the rivers they made me abide."

Surippak, the home of the wise man, on the banks of the Euphrates, of high antiquity before the deluge, is the same as Sippara, where Xisuthros (= Hasisadra), according to Berosus, buried the holy writings before the flood. Its ruins have been found in the Hill of Abu-Habba, about half-way between Babylon (now Hilleh) and Bagdad.[1]

It was "at the mouths of the rivers;" that is, in time of the poem the Euphrates and the Tigris emptied separately into the Persian Gulf. Now the Schat el Arab, formed by the union of the two streams, empties into the gulf, perhaps 400 kilometers below the site of the ancient city, across a delta so low and flat that the tide runs up 300 kilometers, and at Old Nineveh the elevation is only 300 m. Delitsch[2] has collected the evidence that the two streams once flowed separately into the gulf. Pliny says that almost nowhere does the formation of land by a stream advance so rapidly as here. He mentions a town, Alexandria-Antiochia, which, in the third century B. C. was about 1600 m. from the sea,

1 Carl Schmidt, loc. cit., p. 20.

2 Wo lag das Paradies?

and had its own harbor, and 300 years later was 33 km. inland. Other historical documents make it probable that the streams were separate 150 years B. C. Rawlinson says the delta advanced 3·2 km. in 60 years. All the attendant circumstances accord with this location of the story. Here, among a maritime people, as connoisseurs, they ridicule the building of a ship on the land. Ea is the goddess of the sea. And it is marvellous that this trait of the original is preserved in the Koran, where the story is told at length. "And he made the ark, and as often as the elders of his people came by him they ridiculed him, and he said, 'If you rail at us, be sure that we shall also rail at you as you rail at us.'"[1]

From the time of Moses and the tower of Babel, pitch or bitumen had been much used in the Euphrates valley, where the tertiary marls produced it abundantly. In Genesis xi. 3, it says of the tower of Babel, "slime had they for mortar," and a primitive folk still pitches its boats inside and out on the waters of the Euphrates.

Thus the starting-point of the ark is well ascertained, and its landing-place can also be quite clearly located. It was in the land of Nizir, says the record. The Mesopotamian lowland is a narrow, northward extension of the Persian Gulf between the Arabian plateau on the west, and the Zagros Mountains, the scarp of the Persian highlands, on the east. An inscription of Asurnacir-pal, from the same library, reads: "Left Kalzu (by Arbela), and entered the region of the town of Babite, and approached the land Nizir." This is the account of a military expedition, and it followed up the great war road, by which, 500 years later, Darius Codomanus fled from the armies of Alexander. The region of Nizir was east of the Tigris, at the foot of the Zagros chain, 300 feet above the sea, and the craft of Hasisadra must have been swept 160 miles northeast, and stranded in the foothills on the valley border.

Early accounts placed this landing on Mount Judi, in southern Armenia, where a temple in its honor was built in 776 A. D. Berosus places it in the Cordyaian Mountains of Armenia, Genesis in Mt. Ararat (Araxes). It is remarkable how the tradition had clung to this grand volcano. The people still tell of the wood and pitch being carried from the ark as amulets, and dare

[1] Koran, XI. 40, 41.

not attempt to ascend the sacred mountain, and disbelieve the accounts of those few foreigners who have reached the summit. Indeed, a Constantinople newspaper account of a scientific commission sent out by the Turkish government in 1887, to study the avalanches in the mountain, tells of the finding of the ark, encased in the ice of a glacier on the mountain.

We may contrast the Chaldæan and Biblical accounts in several matters. The sending out of the birds and the bow in the heavens join with many other points to prove the identity of the stories.

In many ways the Biblical account is modified to suit the comprehension of an inland folk. While the Gilgamos epic describes a violent hurricane and inundation, which expended its force in six days, the Biblical account describes a long-continued rain of forty days, or, in the Elohistic document, of one hundred and fifty days. "And the waters were dried up from off the earth, and the face of the ground was dry." In the epic the forests were destroyed, and the face of the earth reduced to slime.

Waters rising from great rains would have swept the ship down the valley, while the epic makes it go from the gulf northeast to the region of Nizir. And, indeed, what seems the better translation of the Noachian account agrees with this. Gen. vi. 17, "I do bring a flood of waters" is better translated "I do bring a flood from the sea," and Gen. vii. 6, "Noah was six hundred years old as the flood of waters" (or better, "from the sea") "arose."[1] As Amos says, writing "two years after the earthquake,"[2] "Seek him that maketh the day dark with night, that calleth forth waters of the sea, and poureth them out upon the face of the earth.[3]

We may now try to strip the account of its abundant personification, and see how far it is susceptible of a possible or probable translation into scientific language.

There are, first, the warnings. Hasisatra, the wise man, and, we may assume, wise in the ways of the sea, stands on the shore of the ancient harbor-town, Surippak, and receives the warnings of Ea, goddess of the sea. These were the unusual swellings of the sea from small premonitory earthquake shocks beneath the waters. There is next added a voice, or noise, — a more unusual

[1] J. D. Michaelis (Bunsen); majim = water, mijam = from the sea.

[2] Amos, i. 1.

[3] Amos, v. 8.

warning, — not personified. This may have been the rumbling which may precede any severe earthquake. It is a region where earthquakes are antecedently probable. From the circle of fire that surrounds the Pacific, a zone of seismic activity connects the East and West Indies by way of the Mediterranean, and passes this region. The volcanic area of northern Mesopotamia and Syria is in seismic activity much of the time. Many towns have been several times destroyed, and hundreds of thousands of people have been killed. And the recently-sunken areas of "Lemuria" to the south indicate a region of profound faulting apt for the production of earthquakes.

In the Ægean, the sinking of the great land blocks, by which the sea was formed, is so recent that it is embalmed in the Greek mythology, — Poseidon, god of the sea, ever warring victorious against the gods of the land. And, though rarely noted on the lower Euphrates, earthquakes and seaquakes, as the Germans say, are not rare across the northern parts of the Indian Ocean, the wise man accepts this warning of impending danger, and builds a great craft for the safety of his home, and with the increase of the threatenings embarks his family, regardless of the ridicule of the townsfolk.

"Then arose from the foundations of the heavens a black cloud, in whose middle Ramman (the god of storms) lets his thunders roar, while Neba and Sarru rush at each other in battle. The throne-bearers stalk over mountain and plain." These latter are the great slow-moving sand columns (whirlwinds) which precede and hang on the borders of the coming storm. They still occur around Bagdad, change day into night, and extend over the whole valley of the Euphrates. "The mighty god of pestilence lets loose his hurricanes." So far it is the description of the oncoming of a mighty storm. Then follow elements which may be interpreted as earthquake phenomena. The Biblical account says the foundations of the great deep were broken up, and at the end they were stopped. This may be explained as the uprush of the ground waters, so marked at Charleston and New Madrid, on the Indus plain, at Lake Baikal, where a lake ten by fifteen miles was formed, and in the delta of the river Selenga, when the fastenings of the wells were blown into the air like the corks of bottles. "The Annuniki raise their torches, they make the land glow with their radiant gleams." The

Annuniki are the gods of the underground, the gnomes or kobolds of German saga, and their raising their torches is the inflaming of the natural gases so common in these bituminous tertiary beds, in the fissures opened by the earthquake, — a frequent occurrence also in similar regions on the Caspian.

In the earlier translation by Haupt, the suggestions of earthquake intervention were even more striking than in the later translations. " Adar lets the canals overflow unceasingly. The Annuniki bring floods from the depths. They make the earth tremble by their might." Although hurricane inundations have overwhelmed great areas of land, the earthquake wave is in many ways a mere probable agency here for the production of a flood, exceptional as this must have been to have impressed itself so deeply on this ancient folk. We recall the Lisbon earthquake wave; how the United States warship Monongahela was carried ashore in 1863, at Santa Cruz, and landed on the tops of the houses; or how the great seismic wave of 1868 carried the Wateree in the harbor of Arica, Peru, seven or eight miles inland, landing her in a tropical forest, where she ended her days as an hotel, while her consort, the Fredonia, rolled over and over, and sank with all on board; or the last terrible earthquake waves in Japan and China.

The account then advances strongly to its climax and catastrophe. " Ramman's flood-wave mounts up to heaven." All light sinks in darkness. Terror overcomes gods and men. "Like dogs in their lair the gods crouch at the windows of heaven." This is the description of the incoming of the great cyclonic waves, perhaps reinforced by earthquake waves, for when the seismic tension has just come to equal the resistance, the great additional strain caused by the relief of pressure of the low barometer of the cyclone has not infrequently set loose the impending earthquake. Of 64 hurricanes in the Antilles 7 were accompanied by earthquakes. In the Bay of Bengal, the cyclones average one a year and destroy a million people in a century; and once at Calcutta, in 1737, when the waters rose 40 feet, 14 ships were carried over the trees and 300,000 people were killed; and on the Kistna in 1800 the cyclone and the earthquake occurred together. Indeed, several of these cyclones have been traced across into the Persian Gulf, and one in 1769 was accompanied by an earthquake on the lower Euphrates — the very site of the ancient myth. On the broad plains of the Punjaub

are many indications of similar inundations. I travelled, said Ibn Batuta (1333), through Sind to the town Sahari, on the coast of the Indian Sea, where the Indus joins it. A few miles from here are the ruins of another town, in which stones in the form of men and animals in almost innumerable amount occur. The people were so sinful that God changed them to stone and their animals and their grain. It is interesting to observe the different effect these disturbing events have upon people of different grades of culture.

The Negritos of the Andaman Islands have a demon of the land who causes the earthquakes, a demon of the sea who causes the floods.

The King of Dahomey in 1862 had received the missionaries in the land. The spirit of his fathers shakes the earth because old observances were not followed. The King executes three captive chiefs as an envoy to inform his fathers that the ancient rites shall be re-established.

After the great earthquake of Kioto and Osaka in Japan, in 1596, the warrior Hidiyoshi goes to the temple of Daibutzu (the Buddha), where the enormous bronze statue had been overthrown, and upbraids the fallen idol, and shoots it with arrows.

In 62 A. D. Oppolonius of Tyana, at Phaestus, in Crete, was preaching to a company of worshippers of the local deity, when an earthquake arose. "Peace," he said, "the sea has brought forth a new land." An island was found between Thera and Crete, — Santorin, beloved of all geologists in modern times. The crowd loses all judgment in wonder and admiration.

A true flood panic occurred in the time of Charlemagne. Stöffler, a celebrated astronomer, and professor of mathematics at Tübingen, found, as the result of abstruse calculation, that the earth would be destroyed by a flood in 1524. The news spread rapidly, and filled Europe with alarm. In Toulouse an ark was built by advice of the professor of canonical law, to rescue at least a part of the people. Indeed, in our own days, Prof. Rudolph Falb and similar prophets announce a new flood in the year A. D. 7132.[1] And Falb has by his unverified earthquake predictions caused panics in Athens and Valparaiso.

It is the western migration of this ancient story that is noteworthy, and its association with the punishment of sin by the religious genius of the Hebrews which has made it world-wide.

[1] Schmidt, loc. cit., p. 61.

Such myths of observation, dependent on local floods or the suggestion of fossils, are most widely spread, and they find place in cosmogonic myths, — explanations of the origin of land and sea; national myths, — explanations of the origin of peoples; and myths of destruction of land or people, with or without the idea of punishment for sin.

They are wanting among the Africans and in Australia and Oceanica according to Lenormant; more accurately among the Papuans of Oceanica, for the Feejee Islanders kept great canoes on the hill-tops for refuge when the flood should return.

In China, the great Cyclopedia (2357 B. C.) says: "The waters of the flood are destructive in their inundation. In their wide extent they surround the mountains; overtop the hills; threaten the heaven with their waters; so that the common folk is dissatisfied and complains. Where is the able man who will undertake to control the evil. Kwan tries nine years, Yu, eight years. He completes great works, cuts away woods, controls the streams, dykes them and opens out their mouths. He feeds the people."

This refers to the "Curse of China" the Yang-ze-Kiang which flows sometimes into the Gulf of Pechili north of the promontory of Shantung, sometimes to the south into the Yellow Sea.

Our own Indians gave Catlin 160 flood myths. The dog of the Cherokees is well known. On Cundinamarca in Mexico there were four destructions: — of famine, personified by giants; of fire, by birds; of wind, by monkeys; of water, by fishes.

The Quichés of Guatemala say: As the gods had created animals who did not speak or worship the gods, and had made men from clay who could not turn their heads, — who could speak indeed but not understand anything, — they destroyed their imperfect work by a flood.

A second race of mankind was created, the male of wood, the woman of resin, but it was not thankful to the gods. The gods rained burning pitch on the earth, and sent an earthquake, destroying all but a few, who became monkeys. A third attempt succeeded so well that the gods themselves were terrified at the perfection of their work, and took from them some of their good qualities, and the normal man resulted.[1]

The Arawaks of British Guiana and Venezuela were for their sins twice destroyed, — once by flood, and once by fire, and only the good and wise were saved.

[1] Schmidt, "*Sündflut*," 57.

The flood is a perennial blessing in Egypt, and when the Greeks told the priests of the deluge of Deucalion, they said, "Egypt has been spared this."

There is an inscription on the walls of the tomb of Seti-on, in Thebes, 1350 B.C. The Sun-god, Ra, is wroth with mankind, and the council of the gods decrees its doom. Hathor, queen of the gods, does the work, till all the land is flooded with blood. She sees the fields flooded with blood, she drinks thereof, her soul is glad, she does not know mankind. Only those who, at the right time, fix their thoughts above are spared, and of these the Majesty of Ra sàys: "These are the good."

In Persia there are no flood myths preserved before the time of Zoroaster.

In India, where the flood is a constant scourge, the four Yugas (ages), and the four Manvartaras, the alternate destructions and renewals of the human race, are Vedic myths, and no trace of the flood story appears in the Vedas. The Satapatha-Bramahna, written just before the time of Christ, is especially interesting, from the blending of the Chaldæan account with the Indian mythology. In this oldest account the flood came from the sea, the warning and the rescue of Manu, the Indian Noah, from Vishnu, in form of a fish. Here all the suggestion may be indigenous. There is no punishment.

In the Mahabharata, the ship lands on the highest peak of the Himalaya. In the last part of the story, in the Bhagarata Purana, the motive of the flood is that the wickedness of man was great in the earth. Vishnu, in form of a fish, warns Manu Satjavrata, the well-doer (Ea was a fish-god in the Chaldæan story, and Oannu, in Berosus, was a fish-god), that in seven days the three worlds will sink in an ocean of death, but in the midst of the waves a ship will be provided for Manu. He is to bring all useful plants and a pair of all irrational animals into the ship. The sea rose over its banks, and overwhelmed the earth. Violent wind and cloudburst from measureless clouds contributed to the flood. Vishnu, in form of a gold-gleaming fish, guided the ship. Before the flood the holy Vedas were stolen, afterwards they were restored by Vishnu.

In Greece, also, as the sinking of the land has persisted to greater extent into the most modern times, so the flood-myths have there greater variety and definiteness than elsewhere, and

later the Chaldæan account was grafted on to the earlier with greater fulness. The story is not known to Hesiod in the "Works and Days" (8th century B. C.), though he enumerates several destructions of the sinful race of man, and the "Iliad" mentions destructive cloud-bursts as the usual punishment of heaven on the unjust judge.

Thus, in the Bœotian myth of Ogyges, it is significant that Ogyges was son of Poseidon, god of the sea, and I have heard the name itself derived from an Aryan root, meaning a flood. Ogyges is rescued in a boat.

The story of Deucalion's flood is first given in the Hesiodic catalogues, 800 to 600 B. C. Pyrrha and Deucalion were alone rescued in a ship. As told in an archaic form by Pindar[1] (500 B. C.), "Pyrrha and Deucalion, coming down together from Parnassus, founded their mansion first, and, without marriage union, produced the strong race of the same stock, and hence they were called Laioi, from a word meaning stones, as they threw stones over their heads to form the first men.

Apollodorus (100 B. C.) shows the first influence of the Semitic myth. He extends the flood over almost all Greece, and says Deucalion offered sacrifice on leaving the ship. Later, the ark, the taking-in of animals and sending-out of birds, appear in the Greek myth, and Lucian, or pseudo-Lucian, in "De Dea Syria" (160 A. D.), in a chapter on Hydrophoria, narrates an Armenian flood-myth, which had its home in the upper Euphrates, at Hieropolis, the modern Mambedj, and blends the Hellenic and Semitic story. "The most say that Deucalion Sysythes built the sanctuary, that Deucalion, under whom the great deluge occurred. Of Deucalion I heard also in Hellas the story which the Hellenes tell of him, which runs as follows: The first men had grown very wicked upon the earth, and, in punishment, suffered a great evil. The earth sent up from its bosom mighty masses of water. Heavy rains followed, the rivers swelled, and the sea overflowed the land, until all was covered with water, and all were destroyed; only Deucalion, of all mankind, remained alive. He had built a box or ark, and his family, as also pairs of all kinds of animals, entered into it. All sailed in the ark as long as the waters continued. So the Hellenes write of Deucalion. To this the inhabitants of the holy town add a very strange story; that in their

[1] Olympics, IX. 4 (500 B. C.).

land a great fissure opened in the earth, and this received all the water. Deucalion built altars after this happened, and by the opening built a temple to Here. I saw the opening. It is under the temple, and is very small. As a sign and remembrance of this story, they do as follows: Twice a year water is brought to the temple from the sea. Not alone do the priests bring this,— out of all Syria, and Arabia, India, and from beyond the Euphrates many go down to the sea, and all bring water. They pour it out in the temple, and it flows into the fissure, and the small opening receives a great quantity of water. And this ceremony, they say, Deucalion appointed in the temple in remembrance of the catastrophe and his rescue. A statue of Here is in the temple, and another god, which, although it is Zeus, they call by another name. Between the two stands a golden column. The Assyrians call it the sign, — give it no special name, and cannot explain its origin or its form. Some refer it to Dionysus, others to Deucalion, others to Semiramis. There is on its top a golden dove. Therefore it is said to represent Semiramis. Twice a year it is taken to the sea to bring water, as described above." There were similar Hydrophoria at Athens.

PAPERS READ.

TUESDAY, AUGUST 25.

NOTES ON THE ARTESIAN WELL SUNK AT KEY WEST, FLORIDA, IN 1895. By EDMUND OTIS HOVEY, Amer. Mus. Nat. Hist., New York, N. Y.

THE HYDRAULIC GRADIENT OF THE MAIN ARTESIAN BASIN OF THE NORTHWEST. By Prof. J. E. TODD, Vermilion, So. Dakota.

THE TRUE TUFF-BEDS OF THE TRIAS, AND THE MUD ENCLOSURES, THE UNDERROLLING, AND THE BASIC PITCHSTONE OF THE TRIASSIC TRAPS. By Prof. B. K. EMERSON, Amherst, Mass.

VOLCANIC ASH FROM THE NORTH SHORE OF LAKE SUPERIOR. By Prof. N. H. WINCHELL, University of Minnesota, Minneapolis, and Dr. U. S. GRANT, Geol. Survey of Minnesota, Minneapolis.

THE TYRINGHAM (MASS.) "MORTISE ROCK," AND PSEUDOMORPHS OF QUARTZ AFTER ALBITE. By Prof. B. K. EMERSON, Amherst, Mass.

THE SUCCESSION OF THE FOSSIL FAUNAS IN THE HAMILTON GROUP AT EIGHTEEN MILE CREEK, N. Y. By AMADEUS W. GRABAU, Mass. Inst. of Technology, Boston.

DEVELOPMENT OF THE PHYSIOGRAPHY OF CALIFORNIA. (Lantern pictures.) By Dr. JAMES PERRIN SMITH, Leland Stanford Junior University, Palo Alto, Cal.

SYNOPSIS OF CALIFORNIA STRATIGRAPHY. By Dr. JAMES PERRIN SMITH, Leland Stanford Junior University, Palo Alto, Cal.

ANCIENT AND MODERN SHARKS, AND THE EVOLUTION OF THE CLASS. By Prof. E. W. CLAYPOLE, Akron, Ohio.

INTERGLACIAL CHANGE OF COURSE, WITH GORGE EROSION, OF THE ST. CROIX RIVER, IN MINNESOTA AND WISCONSIN. By WARREN UPHAM, Minn. Hist. Society, St. Paul, Minnesota.

WEDNESDAY, AUGUST 26.

OBSERVATIONS ON THE DORSAL SHIELDS IN THE DINICHTHYIDS. By Dr. CHARLES R. EASTMAN, Mus. Comp. Zoölogy, Cambridge, Mass.

THE DISCOVERY OF A NEW FISH FAUNA, FROM THE DEVONIAN ROCKS OF WESTERN NEW YORK. By F. K. MIXER, Buffalo, N. Y.

ORIGIN OF THE HIGH TERRACE DEPOSITS OF THE MONONGAHELA RIVER. By Prof. I. C. WHITE, University of W. Virginia, Morgantown.

At the afternoon session the Section gave its attention to special exercises in commemoration of the sixtieth anniversary of Professor HALL's connection with the Geological Survey of the State of New York. Addresses were made by Vice-President EMERSON in behalf of the Section, and by President JOSEPH LE CONTE of the Geological Society of America in behalf of that society. Professor HALL responded to these addresses. Several papers relating to the work of Professor HALL and the New York Survey were read. A letter of congratulation from GEORGE M. DAWSON, Director of the Geological Survey of Canada, was read, and a brief address was made by J. F. WHITEAVES of the Canadian Survey. An address was made by T. GUILFORD SMITH of the Board of Regents of the University of the State of New York; and further remarks were made by J. J. STEVENSON, W. H. HALE, W. H. NILES, H. C. HOVEY, and H. L. FAIRCHILD. A communication from Sir J. W. DAWSON concerning Dr. HALL was received too late to be read at the meeting. (For a full report of this meeting, see *Science*, Nov. 13, 1896.)

THE OPERATIONS OF THE GEOLOGICAL SURVEY OF THE STATE OF NEW YORK. By Prof. JAMES HALL, STATE GEOLOGIST, Albany, N. Y.

JAMES HALL, FOUNDER OF AMERICAN STRATIGRAPHIC GEOLOGY. By Dr. W. J. MCGEE, Bureau of Ethnology, Washington, D. C.

PROFESSOR HALL, AND THE SURVEY OF THE FOURTH DISTRICT. By JOHN M. CLARKE, ASST. STATE GEOLOGIST AND PALEONTOLOGIST, ALBANY, N. Y.

THE CUYAHOGA PREGLACIAL GORGE IN CLEVELAND, OHIO. By WARREN UPHAM, Minn. Hist. Society, Minneapolis.

A REVISION OF THE MORAINES OF MINNESOTA. By Prof. J. E. TODD, Vermilion, S. Dakota.

THURSDAY, AUGUST 27.

NOTES ON CERTAIN FOSSIL PLANTS FROM THE CARBONIFEROUS OF IOWA. By Prof. THOMAS H. MACBRIDE, Iowa City, Iowa.

THE MAKING OF MAMMOTH CAVE. By Rev. HORACE C. HOVEY, Newburyport, Mass.

THE COLOSSAL CAVERN. By Rev. HORACE C. HOVEY, Newburyport, Mass.

SHEETFLOOD EROSION. By Dr. W. J. MCGEE, Bureau of Ethnology, Washington, D. C.

FRIDAY, AUGUST 28.

ORIGIN OF CONGLOMERATES. By Prof. T. C. HOPKINS, Geological Survey, Indianapolis, Ind., State College, Centre Co., Pa.

ORIGIN OF TOPOGRAPHIC FEATURES IN NORTH CAROLINA. By COLLIER COBB, Univ. of North Carolina, Chapel Hill, N. C.

THE CRETACEOUS CLAY MARL EXPOSURE AT CLIFFWOOD, N. J. By Prof. ARTHUR HOLLICK, Columbia College, New York, N. Y.

POST-CRETACEOUS GRADE-PLAINS IN SOUTHERN NEW ENGLAND. By F. P. GULLIVER, Norwich, Conn.

THE EOCENE STAGES OF GEORGIA. By GILBERT D. HARRIS, Ithaca, N. Y.

THE ORIGIN AND AGE OF THE GYPSUM DEPOSITS OF KANSAS. By Prof. G. P. GRIMSLEY, Washburn College, Topeka, Kan.

GEOMORPHIC NOTES ON NORWAY. By Dr. J. W. SPENCER, Washington, D. C.

THE SLOPES OF THE DROWNED ANTILLEAN VALLEYS. By Dr. J. W. SPENCER, Washington, D. C.

THE "AUGEN-GNEISS," PEGMATITE VEINS, AND DIORITE DIKES AT BEDFORD, WESTCHESTER Co., N. Y. By LEA McI. LUQUER and Dr. HEINRICH RIES, Columbia College, New York, N. Y.

PRE-CAMBRIAN BASE-LEVELLING IN THE NORTHWESTERN STATES. By Prof. C. W. HALL, Minneapolis, Minn.

A Subsection of Pleistocene Geology was organized at the afternoon session, by the appointment of G. F. WRIGHT as Chairman and H. S. WILLIAMS as Secretary. The following papers were read in this Subsection.

GLACIAL FLOOD DEPOSITS IN THE CHENANGO VALLEY. By Prof. ALBERT P. BRIGHAM, Hamilton, N. Y.

THE NIAGARA FALLS GORGE. By GEORGE W. HOLLEY, Ithaca, N. Y.

THE ALGONQUIN RIVER. By G. K. GILBERT, U. S. Geological Survey, Washington, D. C.

THE WHIRLPOOL SAINT DAVIDS CHANNEL. BY G. K. GILBERT, U. S. Geological Survey, Washington, D. C.

PROFILE OF THE BED OF THE NIAGARA IN ITS GORGE. By G. K. GILBERT, U. S. Geological Survey, Washington, D. C.

ORIGIN AND AGE OF THE LAURENTIAN LAKES AND OF NIAGARA FALLS. By WARREN UPHAM, Minn. Hist. Society, Minneapolis.

Correlation of Warren beaches with moraines and outlets in Southeastern Michigan. By F. B. Taylor, Fort Wayne, Ind.

Notes on the glacial succession in Eastern Michigan. By F. B. Taylor, Fort Wayne, Ind.

Notes on Kansan Drift in Pennsylvania. By Prof. E. H. Williams, Bethlehem, Pa.

Preliminary notes on the Columbian deposits of the Susquehanna. By Dr. H. B. Bashore, West Fairview, Pa.

The Section adjourned Friday afternoon, August 28.

RESOLUTIONS OF SECTION E.

The following resolution, offered by J. J. STEVENSON, was adopted: Resolved that the COUNCIL be and hereby is requested to appoint Prof. E. D. COPE, Prof. JAMES HALL, Prof. B. K. EMERSON, Prof. W. N. RICE, and Prof. C. D. WALCOTT, as delegates to the International Geological Congress to be held in St. Petersburg in 1897; and to authorize them to fill by a majority vote any vacancy which may occur.

[The above named gentlemen were appointed by the COUNCIL as delegates to the Congress, with power to fill vacancies in the number. — *Permanent Secretary.*]

The following resolution, offered by H. L. FAIRCHILD, was adopted: Resolved that Section E requests the COUNCIL of the American Association for the Advancement of Science to permit and authorize the officers of Section E to make such arrangements with the Geological Society of America for the meeting of 1897, that the Geological Society may occupy a portion of the time usually assigned to the Section.

[The above request was granted by the COUNCIL. — *Permanent Secretary.*]

SECTION F.

ZOÖLOGY.

OFFICERS OF SECTION F.

Vice President and Chairman of the Section.

THEODORE GILL, Washington, D. C.

Secretary.

D. S. KELLICOTT, Columbus, Ohio.

Councillor.

C. L. MARLATT, Washington, D. C.

Sectional Committee.

THEODORE GILL, Washington, D. C., Vice-President, 1896.
D. S. KELLICOTT, Columbus, Ohio, Secretary, 1896.
L. O. HOWARD, Washington, D. C., Vice-President, 1895.
C. W. HARGITT, Syracuse, N. Y., Secretary, 1895.
CHAS. C. NUTTING, Iowa City, Ia.
F. M. WEBSTER, Wooster, O.
S. H. GAGE, Ithaca, N. Y.

Member of Nominating Committee.

C. W. HARGITT, Syracuse, N. Y.

Committee to Nominate Officers of the Section.

The Vice-President and Secretary; and J. A. LINTNER, Albany, N. Y.; A. D. HOPKINS, Morgantown, W. Va.; JAS. G. NEEDHAM, Galesburg, Ill.

Press Secretary.

D. S. KELLICOTT, Columbus, Ohio.

ADDRESS

BY

VICE-PRESIDENT

THEODORE GILL,

CHAIRMAN OF SECTION F.

SOME QUESTIONS OF NOMENCLATURE.

INTRODUCTION.

I HAD originally selected for the address which it is my duty and privilege to give to-day a very different subject[1] from that which I am now to discuss; but the renewed and lively interest which is being manifested at present in the ever troublous subject of nomenclature has led me to take it as my theme. I have been especially influenced, too, by the consideration that a committee was appointed at the last Zoölogical Congress, held at Leyden, to consider the subject, and suggestions have been asked for. Of the multitudinous questions that offer for review time will only permit us to examine a few.

Nomenclature, in the modern sense of the word, did not trouble naturalists till near the middle of the last century. The animals and plants of the ancient world were mostly treated of under the names which the Greeks or Romans had used, or were supposed to have used. The forms that became first known after the discovery of America were introduced into the literature under names more or less like those which they bore among the aboriginal inhabitants of the countries from which those forms had been obtained. Only a few names were coined from the Latin or Greek, and used for forms not mentioned by classical authors. Examples of such are *Ammodytes*, and *Anarrhichas*, invented by Gesner. But none of those names were employed as true generic

[1] Animals as Chronometers for Geology.

generally overlooked, and a few of his "canons" may be noticed here. The extent to which each one of the two — Linnæus and Artedi — influenced the other cannot now be learned, nor will it be necessary to consider here who of the two was the abler naturalist. It must suffice that there was almost perfect agreement between Artedi and Linnæus in the spirit of the laws they respectively framed.

COMMENCEMENT OF BINOMIAL NOMENCLATURE.

The question that has been most agitated of late is, what time shall we recognize as the starting-point for the binomial nomenclature. Even now not all will be bound by any such limit for generic nomenclature; but those who will are divided into two main camps, — those who start from the tenth edition of the Linnæan "Systema Naturæ," published in 1758, in which the binomial nomenclature was first universally applied, and those who advocate the twelfth edition of the "Systema," published in 1766, — the last which appeared during the life of Linnæus.

But it may be premised here that even the fact that Linnæus was the first to devise the system of binomial nomenclature is not conceded by all. It has been claimed that about two centuries before Linnæus published his "Philosophia Botanica" Belon had uniformly and consistently applied the binomial nomenclature to plants as well as animals, fishes, and birds.[1] It has been also urged that C. N. Lang (Langius),[2] in 1722, used the binomial nomenclature for shells. I have not been able to confirm either statement, and therefore have to side with the great majority who accord to Linnæus the credit of that achievement.

Almost all the naturalists of the United States accept 1758 as the starting-time for nomenclature, and now most of the naturalists of Europe take the same view. But the English generally accept 1766 for the commencement of their orismology. It was "after much deliberation" that the Committee of the British Association for the Advancement of Science determined on the

[1] Crié (Louis), Pierre Belon et la nomenclature binaire. Rev. Sc., xxx. 737–740, 9 Dec., 1882.

[2] My efforts to see a copy of Lang's "Methodus nova Testacea marina in suas Classes, Genera, et Species distribuendi" (Lucern., 1722) have not been successful. Maton and Rackett say that "he is the first whose generic characters are founded on commodious distinctions," but expressly state that "there are no trivial names." (See Trans. Linn. Soc., vii. 156, 157.) He may have properly appreciated genera.

edition of 1766. It was only because that edition was "the last and most complete edition of Linné's works, and containing many species that the tenth did not," that it was so selected, — surely an insufficient reason. A principle was subordinated to an individual.

Logically, the actual period for the commencement of the binomial nomenclature should be when the rules for that nomenclature were distinctly formulated; and that was 1751, when the "Philosophia Botanica" was first published. Practically, however, it makes little difference for most classes,[1] whether we take that date or 1758, when the next succeeding edition of the "Systema" was published. But it does make much difference whether we take the tenth or twelfth edition. There is really no good reason for keeping Linnæus on that lofty pedestal on which he was enthroned by his disciples of a past century. His work does not justify such an elevation. In every department of zoölogy contemporaries excelled him in knowledge and in judgment. May we not hope that, ultimately, this truth will be recognized, and the tenth edition universally accepted for the first work of the new era?

TRIVIAL NAMES.

The binomial system has come into prominence through a sort of developmental process. Although now generally regarded as the chief benefaction conferred by Linnæus[2] on biology, it was evidently considered by him to be of quite secondary importance.

The first extensive use of it occurs in the "Pan Suecicus," published in 1749, where the author mentions that to facilitate the recording of his observations he had used an "epithet" in place of the differential character.[3] It was thus a mere economical device for the time being.

[1] Arachnology would be most affected, for Clerck's work was published in 1757.

[2] Linnæus himself did not claim this as an improvement in his account of the advancement he had effected in science.

[3] "Possumus nunc ultra duo millia experimenta certissima exhibere, quæ sæpe decies, immo sæpe bis decies sunt iterata. Si autem sumamus FLORAM SUECICAM *Holmiæ*, 1745, & ad quamlibet herbam, ut chartæ parcatur, nomen adponimus genericum, numerum Floræ Suecicæ & epitheton quoddam loco differentiæ, negotium in compendium facile mittitur." Pan Suecicus, pp. 228, 229.

This thesis is attributed to Nicolaus L. Hesselgren in some bibliographies, and naturally so, as it bears his name in the title; but Linnæus probably did not claim more than his own in claiming the authorship, although Hesselgren apparently wrote part of it himself. It is sometimes difficult exactly to fix the authorship in the case of some of the old theses.

In the "Philosophia Botanica" he also treats it as a matter of trivial importance. He distinguishes between the specific name and the trivial.

His *specific* name corresponds to what we would call a *diagnosis* (Nomen specificum est itaque Differentia essentialis); his *trivial* name is what would now be called the *specific*.[1] It is merely suggested that trivial names may be used as in his "Pan Suecicus," and should consist of a single word taken from any source.[2]

This system was fully carried out in the succeeding editions of the "Systema Naturæ." Both names were then given, — the *nomen specificum* after the number of the species, under each genus, and the *nomen triviale* before the number in the margin.

Linnæus placed little store on the trivial names, and accredited such to old botanists; but he took special credit for specific names (or diagnoses), claiming that none worthy of the title had been given before him.[3]

DRACONIAN LAWS.

For generic nomenclature a Draconian code was provided by Linnæus and Artedi. It is now a maxim of good legislation that excessive severity of law is apt to defeat the object sought for, and the tendency of civilization is to temper justice with mercy. So has the tendency of scientific advancement been towards a mitigation of the Linnæan code. Nevertheless, its severity is more or less reflected in later codes, — even the latest, — and therefore a review of some of those old canons will not be entirely

[1] "217. Nomen specificum *legitimum* plantam ab *omnibus* congeneribus (159) distinguat; *Triviale* autem nomen legibus etiamnum caret." Phil. Bot., p. 202.

[2] "NOMINA TRIVIALIA forte admitti possunt modo, quo in *Pane suecico* usus sum; constarent hæc

Vocabula unica;

Vocabula libere undequaque desumta.

Ratione hac præcipue evicti, quod differentia sæpe longa evadit, ut non ubique commode usurpetur, et dein mutatione obnoxia, novis detectis speciebus, est, e. gr.

Pyrola [5 sp.]

Sed nomina Trivialia in hoc opere seponimus, de differentiis unice solliciti." Ph. Bot., pp. 202, 203.

[3] "Trivialia erant antecessorum et maxime Trivialia erant antiquissimorum Botanicorum nomina.

Character Naturalis speciei est *Descriptio; Character* vero *Essentialis* speciei est *Differentia*.

Primus incepi Nomina specifica Essentialis condere, ante me nulla differentia digna exstitit." Ph. Bot., p. 203.

a resurrection of the dead, and may contain a warning for the future.

In exclusiveness for generic names Linnæus and Artedi went far ahead of any of the moderns. They provided that no names were available for genera in zoölogy or botany which were used in any other class of animals or plants, or even which were used for minerals, tools, weapons, or other instruments, or even places.[1]

Under this rule such names as *Acus*, *Belone*, *Citharus*, *Hippoglossus*, *Lingula*, *Novacula*, *Orbis*, *Orca*, *Remora*, *Solea*, and *Umbra* — all now, or some time, in common use — were specified.

The rule was soon relaxed, and any name not previously used in zoölogy, or, at most, biology, was considered admissible.

Another rule sends to Coventry all names composed of two names of different animals, because it might be uncertain to which genus an animal really belongs.[2] The ancient name "Rhino-Batus" is even mentioned as one of the delicts.

This rule is also without any justification, and the reason given for it baseless. Compound words of the kind exiled are in entire harmony with the genius of the classic languages. As an illustration of their use among the Greeks, we need refer to one group only, — that is, compounds with hippos, as *Hippalectryon*, *Hippanthropos*, *Hippardion*, *Hippelaphos*, *Hippocampos*, *Hippotigris*, and *Hippotragelaphos*. (*Hippokantharos*, *Hippomurmex*, *Hippopareos*, and *Hipposelinon* are other classic Greek words, but do not belong to the same category as the others, inasmuch as they were used in a sense analogous to horse-chestnut, horse-mackerel, and horse-radish with us, the word "horse" in this connection conveying the idea of strength, coarseness, or bigness.)

In another rule, all words are proscribed as generic names which are not of Latin or Greek origin;[3] and among the proscribed are such names as *Albula*, *Blicca*, *Carassius*, and many others, which were later used by Linnæus himself as specific names, and which are now used as generic denominations.

1 "Nomina piscium generica, quæ quadrupedibus pilosis, avibus, amphibiis, insectis, plantis, mineralibus, instrumentis opificum etc. communia sunt, omnino deleantur. Linn. Fund. 230." Art. Ph. Ich., § 193.

2 "Nomina generica, ex uno nomine generico fracto, et altero integro composita, exulent. Linn. Fund. 224." Art. Ph. Ich., § 196.

3 "Nomina generica, quæ non sunt originis Latinæ vel Græcæ, proscribantur. Linn. Fund. 229." Art. Ph. Ich., § 198.

Words with diminutive terminations were barely tolerated, if admitted at all,[1] and the reason alleged for such treatment was that the cardinal name might belong to another class. Among the examples named were *Anguilla*, *Asellus*, *Leuciscus*, *Lingula*, *Oniscus*, and *Ophidion*, now familiar in connection with some of our best-known genera. One of these — *Ophidion* — was subsequently used by Linnæus himself as a generic name.

All are now tolerated without demur even, and probably by most naturalists never supposed to have been tainted with offence of any kind. For all such words we have also classical examples; and four have already been named, — the *Oniscus* and *Ophidion* of the Greeks, adopted by the Romans, and the *Anguilla* and *Asellus* of the Latins.

Generic names, derived from Latin adjectives, were also declared to be unworthy of adoption. *Aculeatus*, *Centrine*, and *Coracinus* were cited as examples of words that should be rejected under this rule. Later writers have repeated the denunciations uttered by Linnæus and Artedi, and refused to adopt such words. But hear what Plutarch says of names of men derived from adjectives.

In his life of Coriolanus, Plutarch, in recounting the events subsequent to the capture of Corioli, and the refusal of Marcius to accept more than his share of the booty, comes to the proposition of Cominius.[2]

"Let us, then, give him what it is not in his power to decline, let us pass a vote that he be called *Coriolanus*, if his gallant behaviour at Corioli has not already bestowed that name upon him." Hence came his third name of Coriolanus, by which it appears that Caius was the proper name; that the second name, Marcius, was that of the family; and that the third Roman appellative was a peculiar note of distinction, given afterwards on account of some particular act of fortune, or signature, or virtue of him that bore it. Thus among the Greeks additional names were given to some on account of their achievements, as *Soter, the preserver*, and *Callinicus, the victorious*; to others, for something remarkable in their persons, as *Physcon, the gore-bellied*, and *Gripus, the eagle-nosed*; or for their good qualities, as *Euergetes, the benefactor*, and *Philadelphus, the kind brother*; or their good fortune, as *Eudæmon, the prosperous*, a name given to the second prince of the family of the Batti. Several princes also have had satirical names bestowed upon them: Antigonus (for instance)

1 "Nomina generica diminutiva vix toleranda sunt. Linn. Fund. 227." Art. Ph. Ich., § 202.

2 "Nomina generica imprimis Latina pure adjectiva, sed substantive usurpata, criticorum more improbanda sunt. Linn. Fund. 235." Art. Ph. Ich., § 204.

was called *Doson, the man that will give to-morrow;* and Ptolemy was styled *Lamyras, the buffoon.* But appellations of this last sort were used with greater latitude among the Romans. One of the Metelli was distinguished by the name of *Diadematus*, because he went a long time with a bandage, which covered an ulcer he had in his forehead; and another they called *Celer*, because with surprising celerity he entertained them with a funeral show of gladiators a few days after his father's death. In our times, too, some of the Romans receive their names from the circumstances of their birth; as that of *Proculus*, if born when their fathers are in a distant country; and that of *Posthumus*, if born after their father's death; and when twins come into the world, and one of them dies at the birth, the survivor is called *Vopiscus*. Names are also appropriated on account of bodily imperfections; for amongst them we find not only *Sylla, the red*, and *Niger, the black*, but even *Cæcus, the blind*, and *Claudius, the lame;* such persons, by this custom, being wisely taught not to consider blindness or any other bodily misfortune as a reproach or disgrace, but to answer to appellations of that kind as their proper names."

What was good enough for the ancient Romans to bestow on the most admired of their heroes is good enough for the nomenclature of our genera of animals. We have also examples of names of adjective form used substantively for animals among classic writers. Such, for example, are the *Aculeatus* (pipe-fish), and *Oculata* (lamprey or nine-eyes), mentioned by Pliny.

Linnæus himself, later, coined many names having an adjective form; and three of his genera of plants of one small family, so designated, occur in this region, — *Saponaria*, *Arenaria*, and *Stellaria*. Yet even at the present day we have evidences of the lingering of the old idea embodied in the canon in question.

We have also had drawn up for us certain rules for the conversion of Greek words into Latin, which are tinctured with more than Roman severity. Thus, we are told that Greek names ending in *-os* should always be turned into *-us;* that the final *-on* is inadmissible in the new Latin, and should invariably be rendered by *-um*.

In accordance with such rules, *Rhinoceros* has been turned into *Rhinocerus*, and *Rhinocerotidæ* into *Rhinoceridæ*. But *Rhinoceros* was admitted into classical Latinity, and with it the corresponding oblique cases, *Rhinocerotis*, etc.; in fact, the word was current in the language of description, satire, and proverb, — as when used by Juvenal for a vessel made of the horn, or by Lucilius for a long-nosed man, or by Martial in the proverbial expression, "Nasum rhinocerotis habere"; *i. e.* to turn the nose up, as we should say. These authorities are good enough for me.

The termination *-on* was also familiar to the Romans of classic times, and numerous words with that ending may be found in the books of Pliny. But our modern purists will have none of them; the Greek *-on* in the new Latin must always become *-um*. For example, *Ophidion* was the name given to a small conger-like eel, according to Pliny, and was (without reason) supposed to have been applied to the genus now called *Ophidium;* and this last form was given by Linnæus, who eventually[1] refused to follow Pliny in such barbaric use of Latin. But Pliny is good enough for me — at least as a Latinist.

Another rule prohibits the use of such words as *Ægir*, *Göndul*, *Moho*, *Mitu*, *Pudu*, and the like, and provides that they should have other terminations in accordance with classical usage. But why should those words be changed and surcharged with new endings? As they are, they are all uniform with classical words. *Ægir* has its justification in *Vir*, *Göndul* in *consul*, *Moho* in *homo* (of which it is an accidental anagram), and *Mitu* and *Pudu* are no more cacophonous or irregular than *cornu*. I therefore see no reason why we should not accept the words criticised and corrected by some naturalists in their original form, even if we consider the question involved as grammatical rather than one of scientific convenience.

I have thus defended some of the names of our old nomenclators, and really think that the rules laid down for name-making were too severe. But those rules were on the whole judicious, and should not be deviated from by future nomenclators without good and substantial reason; even if too severe, they "lean to virtue's side." On the other hand, let old names be respected in the interests of stability, even if slightly misformed.

MISAPPLIED NAMES.

While Linnæus was so exacting in his rules of nomenclature in the cases cited, in others he was extremely lax. It is due to him (directly or indirectly) that our lists of genera of vertebrate animals especially are encumbered with so many ancient names that we know were applied to very different animals by the Greeks and Romans. It is Linnæus that was directly responsible for the misuse of such generic names of mammals as *Lemur*,

[1] At first (in the tenth edition) Linnæus allowed *Ophidion*.

Manis, *Dasypus*; such bird-names as *Trochilus*, *Coracias*, *Phaëton*, *Diomedea*, *Meleagris*, and (partly with Artedi) such fish-names as *Chimæra*, *Centriscus*, *Pegasus*, *Callionymus*, *Trigla*, *Amia*, *Teuthis*, *Esox*, *Elops*, *Mormyrus*, and *Exocœtus*. These all were applied, by the ancients, to forms most of which are now well ascertained, and the animals to which they have been transferred have nothing in common with the original possessors of the names.

The misuse of these ancient names is in contravention of the rule adopted by the International Zoölogical Congress held in Moscow (1892), that "every foreign word employed as a generic or specific name should retain the meaning it has in the language from which it is taken," and of like rules of other associations. The false application by Linnæus and his followers (and he had many) was due partly to the belief that the ancient names were unidentifiable, but now there are few whose original pertinence is not known. It may be thought by some, however, that we are unduly criticising the doings of the past from the vantage-ground of the present. But such is not the case, for at the commencement of his career Linnæus was taken to task for the fault indicated. Some of those criticisms were so apt that they may be advantageously repeated here.

Dillenius, of Oxford, wrote to Linnæus in August, 1737, in these terms: —

"We all know the nomenclature of Botany to be an Augean stable, which C. Hoffmann, and even Gesner, were not able to cleanse. The task requires much reading, and extensive as well as various erudition; nor is it to be given up to hasty or careless hands. You rush upon it, and overturn everything. I do not object to Greek words, especially in compound names; but I think the names of the antients ought not rashly and promiscuously to be transferred to our new genera, or those of the new world. The day may possibly come when the plants of Theophrastus and Dioscorides may be ascertained; and, till this happens, we had better leave their names as we find them. That desirable end might even now be attained if any one would visit the countries of these old botanists, and make a sufficient stay there; for the inhabitants of those regions are very retentive of names and customs, and know plants at this moment by their antient appellations, very little altered, as any person who reads Bellonius may perceive. I remember your being told, by the late Mr. G. Gherard, that the modern Greeks give the name of *Amanita* (ἀμανίτα) to the eatable Field Mushroom; and yet, in *Critica Botanica*, p. 50, you suppose that word to be French. Who will ever believe the *Thya* of Theophrastus to be our *Arbor Vitæ?* Why do you give the name of Cactus to the *Tuna?* Do you believe the *Tuna*, or *Melocactus*

(pardon the word), and the *Arbor Vitæ*, were known to Theophrastus? An attentive reader of the description Theophrastus gives of his *Sida*, will probably agree with me that it belongs to our *Nymphæa*, and indeed to the white-flowered kind. You, without any reason, give that name to the *Malvinda*; and so in various other instances concerning antient names; in which I do not, like Burmann, blame you for introducing new names, but for the bad application of old ones. If there were, in these cases, any resemblance between your plants and those of the antients, you might be excused, but there is not. Why do you, p. 68, derive the word *Medica* from the virtues of the plant, when Pliny, book xviii. chap. 16, declares it to have been brought from Media? Why do you call the *Molucca*, *Molucella*? It does not, nor ought it, to owe that name, as is commonly thought, to the Molucca islands; for, as Lobel informs us, the name and the plant are of Asiatic origin. Why then do you adopt a barbarous name, and make it more barbarous? *Biscutella* is not, as you declare, p. 118, a new name, having already been used by Lobel. I am surprised that you do not give the etymology of the new names which you or others have introduced. I wish you would help me to the derivation of some that I cannot trace; as *Ipomæa* for instance. Why are you so much offended with some words, which you denominate barbarous, though many of them are more harmonious than others of Greek or Latin origin?"

A year later (August 28, 1738) he again wrote:—

"It would surely have been worth your while to visit Greece, or Asia, that you might become acquainted with, and point out to us, the plants of the antients, whose appellations you have so materially, and worse than any other person, misapplied. You ought to be very cautious in changing names and appropriating them to particular genera."

How entirely the previsions of the wise old botanist have been realized, I need not explain. We now know what almost all of the names misapplied by Linnæus and his school were meant for of old; and when some more good naturalists collect names and specimens together in various parts of Greece, probably very few of the ancient names will remain unidentifiable.

The only reply that Linnæus could make to the censures of Dillenius appears in the following minutes:—

"With regard to unoccupied names in antient writers, which I have adopted for other well-defined genera, I learned this of you. You, moreover, long ago, pointed out to me that your own *Draba*, *Nova Pl. Genera* 122, is different from the plant so called by Dioscorides."

The retort of one sinner that his antagonist is another is no real answer.

The comments of the British Committee of 1865, on this subject, are very judicious and pertinent.

The use of mythological names for animals and plants is far

less culpable. The use of such is no worse than that of any meaningless name. Sometimes, even, there may be conveyed an association of ideas which appeals to the imagination in a not disagreeable manner. For example, Linnæus gave the name *Andromeda*, after the Ethiopian maid whose mother's over-great boasts of the daughter's beauty made her the victim of Poseidon's wrath. Linnæus justified his procedure by a remarkable play of fancy.

"This most choice and beautiful virgin gracefully erects her long and shining neck (the peduncle), her face with its rosy lips (the corolla) far excelling the best pigment. She kneels on the ground with her feet bound (the lower part of the stem incumbent), surrounded with water, and fixed to a rock (a projecting clod), exposed to frightful dragons (frogs and newts). She bends her sorrowful face (the flower) towards the earth, stretches up her innocent arms (the branches) toward heaven, worthy of a better place and happier fate, until the welcome Perseus (summer), after conquering the monster, draws her out of the water and renders her a fruitful mother, when she raises her head (the fruit) erect."

The relation of the old myth to the plant may be far fetched, and no other would ever be likely to notice the analogy without suggestion ; but at least the conceit is harmless, if not agreeable.

The analogy that gave rise to this fanciful description, contained in the "Flora Lapponica," suggested itself to Linnæus on his Lapland journey.

"The Chamædaphne of Buxbaum was at this time in its highest beauty, decorating the marshy grounds in a most agreeable manner. The flowers are quite blood-red before they expand, but when full grown the corolla is of flesh-colour. Scarcely any painter's art can so happily imitate the beauty of a fine female complexion ; still less could any artificial colour upon the face itself bear comparison with this lovely blossom. As I contemplated it, I could not help thinking of Andromeda as described by the poets ; and the more I meditated upon their descriptions, the more applicable they seemed to the little plant before me ; so that, if these writers had had it in view, they could scarcely have contrived a more apposite fable. Andromeda is represented by them as a virgin of most exquisite and unrivalled charms ; but these charms remain in perfection only so long as she retains her virgin purity, which is also applicable to the plant, now preparing to celebrate its nuptials. This plant is always fixed on some little turfy hillock in the midst of the swamps, as Andromeda herself was chained to a rock in the sea, which bathed her feet, as the fresh water does the roots of the plant. Dragons and venomous serpents surrounded her, as toads and other reptiles frequent the abode of her vegetable prototype, and, when they pair in the spring, throw mud and water over its leaves and

branches. As the distressed virgin cast down her blushing face through excessive affliction, so does the rosy-colored flower hang its head, growing paler and paler till it withers away. Hence, as this plant forms a new genus, I have chosen for it the name of *Andromeda*."

DOUBLE NAMES.

It was long the custom, when a specific name was taken for a genus, to substitute a new specific for the one so diverted. There was some reason for this, for sometimes the specific name covered several forms, or at least was equally applicable to several; of late, however, the acceptance of both the generic and specific names, that is, the duplication of a name, has been quite general, and various precedents have been adduced in favor of the procedure. "In the solemn anthem musicians have been known to favor such repetitions, the orator uses them, in poetry they occur without offence, and even our English aristocracy sometimes bears them as an added grace."[1] It is also a frequent custom in many barbarous and half-civilized races, as well as the young of our own, to double the name for a given subject; and this analogy may be regarded by some of you as a perfect one. But in the last cases some regard is had for euphony, and it is a short word that is repeated, as in the case of the Kiwi-Kiwi and Roa-Roa of the Maoris of New Zealand, the Pega-Pega of the indigenes of Cuba, the Willie-Willie (water spout) of the Australians, and our own familiar Pa-pa and Ma-ma. Many scientific names repeated are long, — some very long, — but even for such I would now yield the point. Stability of nomenclature is a greater desideratum than euphony or elegance. But here let me add that there is a history behind the *Scomber Scomber*, which has been frequently cited as an example of the duplication of a name by Linnæus. It was *Scomber Scombrus* that was used at first by the early nomenclator, and that occurs in the tenth edition of the "Systema Naturæ" (p. 297), as well as in the "Fauna Suecica" (2d ed., p. 119). Linnæus thus combined the old Latin and Greek names of the mackerel, which were formally different, although of course traceable to one and the same root. The name is therefore not repulsive, but interesting as a historical reminiscence of past usage by two great peoples. It was only in the twelfth edition of the "Systema"

[1] Stebbing in Nat. Science, viii. 255.

(p. 492) that Linnæus exactly duplicated the name as *Scomber Scomber*, and thus vitiated the last edition in this as he did in other cases. But it is at least possible that the exact duplication of names in the twelfth edition is the offspring of typographical inaccuracy or clerical inadvertence. At any rate, those who recognize the tenth edition of the "Systema" as the *initium* of nomenclature will adopt the more elegant form.

VARIANTS AND SIMILARITY OF NAMES.

The case of *Scomber* and *Scombrus* naturally suggests consideration of another rule adopted by various societies. By the German Zoölogical Society it is provided that "names of the same origin, and only differing from each other in the way they are written, are to be considered identical."[1] Words considered identical are *Fischeria* and *Fisheria*, as well as *Astracanthus* and *Asteracanthus;* and among words sufficiently different are *Polyodon*, *Polyodonta*, and *Polyodontes*.

When rules are once relaxed in this indefinite manner, the way is at once open to differences of opinion as to what are to be considered identical or too much alike. *Fischeria* and *Fisheria* appear to me to be sufficiently distinct, and would be so considered by some who would think that *Polyodon*, *Polyodonta*, and *Polyodontes* are too nearly alike. While the last three are conceded to be sufficiently distinct by the German Zoölogical Society, analogous forms, as *Heterodon* and *Heterodontus*, are claimed by some zoölogists to be too similar, and consequently the latter prior and distinctive name of the "Port Jackson shark" is sacrificed in favor of the later and inapt *Cestracion*, — a name originally coined and appropriate for the hammer-headed sharks, but misapplied to the Australian shark.

I agree with those who think that even a difference of a single

[1] "Etymologisch gleich abgeleitete und nur in der Schreibweise von einander abweichende Namen gelten als gleich.

Beispiele: *silvestris = sylvestris; cæruleus = cœruleus; linnæi = linnei; Fischeria = Fisheria; Astracanthus = Asteracanthus.*

a. Dagegen können neben einander verwendet werden *Picus* und *Pica; Polyodon, Polyodonta*, und *Polyodontes; fluvialis, fluviatilis, fluviaticus, fluviorum; moluccensis* und *moluccanus.*

b. Bei Neubildung von Namen möge man solche vermeiden, welche leicht mit schon vorhandenen verwechselt werden können." Regeln . . . von der Deutsch. Zool. Ges., § 4.

letter in most cases is sufficient to entitle two or more generic names so differing to stand. The chemist has found such a difference not only ample, but most convenient to designate the valency of different compounds, as ferr*i*cyanogen, and ferr*o*cyanogen. I am prepared now to go back on myself in this respect. In 1831 Prince Max of Nieuwied named a bird *Scaphorhynchus*, and in 1835 Heckel gave the name *Scaphirhynchus* to a fish genus. In 1863 I used a new name (*Scaphirhynchops*) for the acipenseroid genus, and that name was adopted by other naturalists. Jordan later considered the literal differences between the avine and piscine generic names to be sufficient for both. I yield the point, and abandon my name, *Scaphirhynchops*. But those who hold to the rule in question will retain it.

Another set of cases exhibiting diversity of opinion may be exemplified.

In 1832 Reinhardt gave the name *Triglops* to one cottoid genus, and in 1851 Girard named another *Triglopsis*, Girard apparently not knowing of Reinhardt's genus. In 1860 the later name was replaced by *Ptyonotus*. All American naturalists have repudiated the last name.

In 1854 Girard named a genus of Atherinids *Atherinopsis*, and in 1876 Steindachner, knowing well the name of Girard, deliberately called a related genus *Atherinops*. No one, as yet, has questioned the availability of the later name, but one who refuses to adopt *Triglopsis* because of the earlier *Triglops* must substitute another name for *Atherinops*.

Who shall decide in such cases, and what shall be the standard?

MAKING OF NAMES.

It was long ago recognized, even by Linnæus, that the rigor of the rules originally formulated by him would have to be relaxed. Naturalists early began to complain that the Greek and Latin languages were almost or quite exhausted as sources for new names, and many resorted to other languages, framed anagrams of existent ones, or even played for a jingle of letters.

Forty years ago one of the most liberal of the American contributors to such names[1] defiantly avowed that "most of the genera [proposed by him] have been designated by words taken

[1] Girard in Proc. Acad. Nat. Sc. Phila., viii. 209, 1856.

from the North American Indians, as being more euphonic than any one [he] might have framed from the Greek. The classic literature has already furnished so many names that there are but few instances in which a name might yet be coined, and express what it is intended to represent. [He] offered this remark as a mere statement, not as an apology." He gave such names as *Minomus*, *Acomus*, *Dionda*, *Algoma*, *Algansea*, *Agosia*, *Nocomis*, *Meda*, *Cliola*, *Codoma*, *Moniana*, *Tiaroga*, *Tigoma*, *Cheonda*, and *Siboma*.

These names have caused some trouble, and have been supposed to be original offspring of the ichthyologist; but those familiar with Longfellow's Hiawatha will recognize in *Nocomis* the name of the daughter of the Moon[1] and mother of Wenonah (Nokomis), corrected by classical standard ! and in *Meda* the title of a "medicine man" (not "a classical feminine name"). Other names are geographical or individual.

In the excellent report to the International Zoölogical Congress, by Dr. Raphael Blanchard (1889), it was remarked that it would be generally conceded that naturalists have almost completely exhausted the Greek and Latin words, simple and compound, possible to attribute to animals.[2]

But the classic languages are even yet, although about one hundred thousand names[3] grace or cumber the nomenclators, far from being completely exploited. To some of us, indeed, the difficulty in determining upon a new name is that of selection of several that are conjured up by the imagination rather than the coining of a single one.

Besides the methods of name-making generally resorted to, there are others that have been little employed. Among the few who have resorted to other than the regular conventional ways is the illustrious actual President of the American Association for the Advancement of Science. His long list of generic names proposed in the various departments of zoölogy embraces many of unusual origin, and almost always well formed, elegant, and

[1] "From the full moon fell Nokomis,
Fell the beautiful Nokomis."
The Song of Hiawatha, III., lines 4, 5.

[2] "On conviendra que les naturalistes ont dû épuiser à peu près complètement la liste des mots grecs ou latins, simples ou composés, qu'il était possible d'attribuer aux animaux." Bull. Soc. Zool. France, xiv. 223.

[3] The number one hundred thousand includes duplicates and variants.

euphonious. I can only adduce a few of the ways of naming illustrated by classical examples.

In ancient Greek there are numerous words ending in *-ias*, and many substantives with that termination are names of animals given in allusion to some special characteristic.

Acanthias is the designation of a shark, especially distinguished by the development of a spine at the front of each dorsal fin; the name is derived from ἄκανθα, spine, and the terminal element.

Acontias is the name of "a quick-darting serpent," and the main component is ἄκων, a dart or javelin.

Anthias is the name of a fish found in the Mediterranean and distinguished by the brilliancy of its color; evidently it was based on ἄνθος, a flower. The color of the fish may remind one of a showy flower.

Xiphias is the ancient as well as zoölogical designation of the sword-fish; it was plainly coined from ξίφος, a sword.

These four names give some idea of the range of utility of the particle in question; they involve the ideas of defensive armature, offensive armature, ornamentation, and action.

A number of names have been framed by modern zoölogists in conformity with such models. Such are *Stomias* (named by the Greek scholar and naturalist, Schneider) and *Ceratias*, — types of the families *Stomiidæ* (generally written *Stomiatidæ*) and *Ceratiidæ*. *Tamias* is another name, well known in connection with the chipmunk.

But there is room for many more of like structure. For examples, peculiarities of various parts might be hinted at by such words as *Carias* or *Cephalias* or *Cotidias* or *Cottias* (for animals having some distinctive character in the head), *Chirias* (hand or hand-like organ), *Gnathias* (jaw), *Podias* (feet), *Thoracias* (thorax), and many others of analogous import.

Another termination which might be used advantageously instead of the too often used *-oides* is the patronymic suffix *-ides*. This would be specially useful where genetic relationship is desired to be indicated. We have many such models in classical literature, as Alcides, the son of Alcæus, Atrides, the son of Atreus, Pelides, the son of Peleus, Æacides, the grandson of Æacus, and the like.

Another source for help in name-making is in the several

intensive Greek particles occurring as prefixes of various names. The chief of these prefixes are *agi-*, *ari-*, *da-*, *eri-*, *eu-*, and *za-*. *Eu-* has been so very often drafted into use that relief and variety may be found by resorting to the others.

Ari- (Ἀρι-) occurs often in classical words, as ἀρίδακρυς, very tearful, ἀρίδηλος, very plain, and ἀριπρεπής, very showy.

Da (Δᾶ-) is illustrated by such names as δάσκιος (daskios, shaded) and δαφοινός (daphoinos, deep red), — convert them, if you will, into *Dascius* and *Daphœnus*. Numerous names may be made on the model, although in classical Greek there are few.

Eri- (Ἐρι-) is used in the same way as *Ari-*, and is familiar in ancient Greek as a particle of such words as ἐριαυγής (very brilliant) and ἐριαύχην (with a high arched neck). The common large seal of northern Europe (*Erignathus barbatus*) has received its generic name, based on the same model, on account of the depth of the jaws. Very few naturalists, however, have availed themselves of this particle for name-making, most of the words in the zoölogical nomenclators commencing with *Eri-* having other origins.

Za- (Ζα-) is met with in such words as ζᾱής (strong blowing), ζᾰθερής (very hot), ζάκαλλής (very beautiful), ζάπλουτος (very rich), ζαπότης (a hard drinker). The particle has been utilized in the composition of the generic name (*Zalophus*) of the common sea-lion, distinguished by its high sagittal crest (ζά- and λόφος, crest), familiar to menagerie visitors, and the residents and travellers in San Francisco. Professor Cope has also made use of it for several of his names.

We have been told by ancient writers that Cicero was a name derived from *cicer*, a vetch. According to Pliny, the name (like *Fabius* and *Lentulus*) was obtained on account of ancestral skill in cultivation of the plant; but, according to Plutarch, the original of the name was so called because he had a vetch-like wen on his nose.[1] Which one (if either) was the fact is of no material consequence. The etymological propriety of both is sanctioned by the suppositions of classical writers. There can then be no valid objection to other names formed on the model.

There is one rule which has been put in such a form (and without proper exceptions) that a number of names, improper accord-

[1] Those familiar with the "Spectator" may recall Addison's allusion to this (No. 59). See also Middleton's Life of Cicero.

ing to classical standards, have been introduced. The rule is that the aspirate of Greek should be rendered by *h*. While this is true for the commencement of a name, it is not for the body, where it generally is suppressed, being sonant only after *p*, *t*, or *k*. The Greeks, accordingly, wrote *Philippos* (Φίλιππος) and *Ephippus* (Ἔφιππος). In accordance with such models *Mesohippus* and *Orohippus* should have been called *Mesippus* and *Orippus*. *Protohippus* should have been *Prothippus*. *Epihippus* might by some be considered to be preoccupied by *Ephippus*, a genus of fishes. But, in my opinion, all the names should be retained as they are (if there is no other objection), on the assumption that more confusion would result from sacrifice of priority than of classical excellence.

From names as names, I proceed to the consideration of fitting them to groups.

TYPONYMS.

The question what is necessary to insure reception of a generic name is one of those concerning which there is difference of opinion. By some a definition is considered to be requisite, while by others the specification of a type is only required. But the demand in such case is simply that the definition shall be made. It may be inaccurate or not to the point; it may be given up at once, and never adopted by the author himself afterwards, or by any one else. Nevertheless, the condition is fulfilled by the attempt to give the definition. In short, the attempt is required in order that the competency (or its want) of the namer may be known, and if incompetency is shown thereby — no matter! The attempt has been made. The indication by a type is not sufficient.

Any one who has had occasion to investigate the history of some large group must have been often perplexed in determining on what special subdivision of a disintegrated genus the original name should be settled. The old genus may have been a very comprehensive one, covering many genera, and even families of modern zoölogy, and of course the investigator has to ignore the original diagnosis. He must often acknowledge how much better it would have been if the genus had been originally indicated by a type rather than a diagnosis. Many naturalists, therefore, now recognize a typonym to be eligible as a generic name.

Among such are those guided by the code formulated by the American Ornithologists' Union, to which reference may be made, and in which will be found some judicious remarks on the subject under "Canon XLII." Certainly it is more rational to accept a typonym than to require a definition for show rather than use. Nevertheless, I fully recognize the obligation of the genus-maker to indicate by diagnosis, as well as type, his conception of generic characters.

FIRST SPECIES OF A GENUS NOT ITS TYPE.

On account of the difficulty of determining the applicability of a generic name when a large genus is to be subdivided, it has been the practice of some zoölogists to take the first species of a genus as its type. This, it has been claimed, is in pursuance of the law of priority. It is, however, an extreme, if not illegitimate, extension of the law, and has generally been discarded in recent years. But in the past, it had eminent advocates, such as George Robert Gray in Ornithology, and Pieter Van Bleeker in Ichthyology. A few still adhere to the practice, and within a few months two excellent zoölogists have defended their application of names by statements that the first species of the old genera justified their procedure. The contention of one involves the names which shall be given to the crayfishes and lobsters.

It is evident that the fathers of zoölogical nomenclature never contemplated such a treatment of their names, and the application of the rule to their genera would result in some curious and unexpected conditions. Let us see how some genera of Linnæus would fare. The first species of *Phoca* was the fur seal, the first species of *Mustela* the sea-otter, the first of *Mus* the guinea-pig, and the first of *Cervus* was the giraffe. These are sufficient to show what incongruities would flow from the adoption of the rule.

CHOICE OF NAMES SIMULTANEOUSLY PUBLISHED.

There is another issue of nomenclature involving many genera. In the same work different names have been given to representatives or stages of what are now considered the same genus. For example, Lacépède, in the third volume of his "Histoire Naturelle des Poissons," published two names, *Cephalacanthus* and *Dactylopterus*, the former given to the young and the latter to the adult stage of the flying gurnard. *Cephalacanthus* appeared on page

323, and *Dactylopterus* on page 325. *Dactylopterus* is the name that has been generally adopted for the genus, but some excellent naturalists now insist on the resurrection and retention of *Cephalacanthus*, for the reason that the latter was the first given name. In connection with an analogous case, it was urged that "the law of primogeniture applies to twins." There is a fallacy involved in such a comparison, which becomes obvious enough on consideration. In the case of twins, the birth of one precedes that of the other by a very appreciable interval of time. But in the case of names appearing in the same volume (issued as a whole) the publication is necessarily simultaneous. It is therefore, it appears to me, perfectly logical to take the most appropriate name, or to follow the zoölogist who first selected one of the names. In the case of *Dactylopterus*, there would be the further advantage that the current nomenclature would not be disturbed.

It is interesting to note that those who have acted on the principle just condemned do not feel called upon to accept the first species of a genus as its type.

MAJOR GROUPS AND THEIR NOMENCLATURE.

Another subject to which I would invite your attention is the amount of subdivision of the animal kingdom which is expedient, and the nomenclature of such subdivisions.

Linnæus only admitted four categories, — class, order, genus, and species. These sufficed for most naturalists during the entire past century. Only one naturalist — Gottlieb Conrad Christian Storr — went into much greater detail; he admitted as many as eleven categories, which may be roughly compared with modern groups as follows: —

Agmen	Rubrisanguia [= Vertebrata]	Subkingdom
Acies	{ Warm-blooded Cold-blooded }	Superclass
Class	Mammalia	Class
Phalanx	{ Pedata Pinnepedia Pinnata }	Subclass
Cohors	{ Unguiculata Ungulata }	Superorder
Ordo		Order
Missus		Suborder
Sectio		Family
Cœtus		Subfamily
Genus		Genus
Species		Species

These groups are really not exactly comparable with any of recent systematists, inasmuch as Storr proceeded from a physiological instead of a morphological base in his classification. The only work in which this classification was exhibited was in his "Prodromus Methodi Mammalium," published in 1780.

With this exception, the naturalists of the last century *practically* recognized only four categories, — species, genera, orders, and classes. Families were introduced into the system by Latreille. The word "family," it is true, was not unknown previously, but it had been used only as a synonym for order. In botany such usage even prevails, to some extent, at the present day, and persists as a heritage of the past. The French botanists used "famille" as the equivalent of "ordo." Our English and American botanists followed and used "order" as the more scientific designation, and "family" as a popular one; Gray, for example, calling the family represented by the buttercups the "Order Ranunculaceæ," or "Crowfoot Family." But in zoölogy the two names became early differentiated, and while order was continued in use with the approximate limits assigned to it by Linnæus, family was interposed as a new category, intermediate between the order and genus. At first this category generally was given a descriptive designation; but soon the tendency to employ, as a part of the designation, the stem of the principal generic name, became marked, and the use of the patronymic suffix *-idæ* in connection with a generic name was adopted, and, as time has advanced, has become more and more general. But the assent to this method is not universal. There are still some excellent zoölogists who refuse to be bound by the rule, and who adopt the oldest family name, whether it be denominative or patronymic, and whatever may be the termination.

The five categories thus recognized were very generally admitted, and for a long time were the only ones recognized by many naturalists. But gradually suborders, subfamilies, and subgenera were taken up. Further, the word "tribe" was often used, but with different applications. Still other divisions were occasionally introduced, but the most elaborate of all the schemes for gradation of the groups of the animal kingdom were those proposed by Bleeker and Haeckel.[1] They are reproduced in the

[1] Generelle Morphologie der Organismen, ii. 400.

following parallel columns, in which their applications to fishes and mammals are likewise shown.

Vertebrata	Phylum		
Pachycardia	Subphylum		
Allantoidia	Cladus		
	Subcladus		
Mammalia	CLASSIS	CLASSIS	*Pisces*
Monodelphia	Subclassis	Subclassis	*Monopnoi*
		Divisio	*Dirhinichthyes*
Deciduata	Legio	Legio	*Eleutherognathi*
Discoplacentalia	Sublegio	Sublegio	*Ctenobranchii*
		Series	*Isopleuri*
		Subseries	*Kanonikodermi*
		Phalanx	*Alethinichthyes*
		Subphalanx	*Neopoiesichthyes*
		Caterva	*Katapieseocephali*
Rodentia	Ordo	Ordo	*Percæ*
	Subordo	Subordo	*Percichthyini* [sic !]
Myomorpha	Sectio	Sectio	*Paristemipteri*
	Subsectio		
		Tribus	*Percichthyini* [sic !]
Murina	FAMILIA	FAMILIA	*Percoidei*
	Subfamilia	Subfamilia	*Percæformes*
Arvicolida	*Tribus*	*Cohors*	
Hypudæi	*Subtribus*	Stirps	
Arvicola	GENUS	GENUS	*Perca*
	Subgenus		
Paludicola	*Cohors*		
	Subcohors		
Arvicola amphibius	SPECIES	SPECIES	*Perca fluviatilis*
	Subspecies		
Arvicola (amphibius) terrestris	Varietas		
Arvicola (amphibius terrestris) argentoratensis	Subvarietas		

Here we have a total of 31 categories intermediate between the kingdom and the individual of an animal form. The tools have become too numerous, and some were rarely used by the authors themselves. Thus the cohors and stirps were not called into requisition by Bleeker for the Percoidei (though they were for the subdivision of the Cyprinoidei), and in the recent classification of the Radiolarians, Professor Haeckel did not find it necessary to draw upon the tribus or subtribus for the arrangement of any family. None others have adopted in detail either of the elaborate schemes proposed by their distinguished authors, and even those authors themselves have not, in their later works, gone into the details they provided for in their schemes. The only divisional name that has been used to any great extent is tribe. That has been frequently employed, but in different ways, — sometimes for the division of an order, sometimes within a suborder,

sometimes for a section of a family, again for a part of a subfamily, and even for a fragment of a genus.[1] In two of these widely differing ways it has been used in the systems of Bleeker and Haeckel. It is evident, however, that more groups than the old conventional ones, which alone Agassiz admitted, would be useful at the present. A happy mean seems to me to be realized in the following list: —

Branch	Superfamily
Subbranch	Family
Superclass	Subfamily
Class	Supergenus
Subclass	Genus
Superorder	Subgenus
Order	Species
Suborder	Subspecies.

There are only two (or three for trinomialists) of these which are "sonant," all the others being "mute" (to use the expression of Linnæus); but a question of termination affects several of them.

All the supergeneric groups, like families, were originally chiefly designated by descriptive names, but the trend in all the years has been towards names which are based on the stems of existing genera.

FAMILY.

In 1796 ("an 5 de la R."), Latreille, in his "Précis des Caractères génériques des Insectes," for the first time employed the term "family" as a subdivision of an order, but only gave the families numbers ("Famille première," "Fam. 2," etc.).[2] He remarked that it might be desirable to have the families named, but deferred doing so till he could review the subject with greater care.[3]

In 1798 ("an 6"), Cuvier, in his "Tableau Élémentaire de l'Histoire naturelle des Animaux," in the introduction, when treating of graded characters ("*caractères gradués*"), named

[1] The words Phalanx, Cohors, and Series (if not others) have been used recently in another manner by Dr. F. A. Smitt in the "History of Scandinavian Fishes." The sequence in that work is Classis, Ordo, Subordo, Phalanx, Cohors, Séries, Familia, Subfamilia, Genus, Subgenus, Species.

[2] "Les rapports anatomiques, ceux de *l'Habitus*, des métamorphoses, ont été mes guides dans la formation des familles. Elles sont précédées d'un chiffre arabe." p. ix.

[3] "On eut désiré que j'eusse donné des noms aux familles; mais prévoyant que je serois contraint d'y faire plusieurs changemens, j'eusse ainsi exposé la nomenclature à une vicissitude très contraire à l'avancement de la science." p. ix.

only the genus, order, class, and the kingdom. In the body of the work, sometimes he used the word "family" instead of order (as for the Birds), but for two orders of the Insects he formally adopted a division into families which were regularly named. The first (unnamed) order ("ordre"), with jaws and without wings (" Des insectes pourvus de mâchoires, et sans ailes"), was divided into several families ("plusieurs familles naturelles"), — " les Crustacés," " les Millepieds," " les Aracnéides," and " les Phtyréides." The order Névroptères was disintegrated into three families (" trois familles naturelles"), — " les Libelles," " les Perles," and " les Agnathes." The representatives of the other (six) orders were distributed directly into genera.

This, so far as I have been able to discover, was the first time in which an order of the animal kingdom was regularly divided into named families, designated as such.

In 1806, Latreille, in his "Genera Crustaceorum et Insectorum," gave names to families, but on no uniform plan, providing descriptive names for some, as " *Oxyrhinci* " for the Maioidean crabs, — names based on typical genera, with a patronymic termination, as *Palinurini* and *Astacini*, and, in other cases, names also based on a typical genus but with a quasi plural form, as *Pagurii*. (In the same work, it may be well to add, Latreille also admitted more categories than usual, using ten for the animal kingdom, — Sectio, Classis, Legio, Centuria, Cohors, Ordo, Familia, Tribus, Genus, and Species.)

In 1806, A. M. Constant Duméril, who had previously contributed tables of classification to Cuvier's "Leçons d'Anatomie Comparée," and published his own " Élémens d'Histoire Naturelle," brought out his " Zoologie Analytique." In this volume, he gave analytical tables for the entire animal kingdom, and admitted families for all the classes. The families were generally subordinated to orders; but when the structural diversity within a class did not appear sufficient to require more than one "mute" category, the order was sacrificed in favor of the family. His families were generally very comprehensive, often very unnatural, and mostly endowed with descriptive names. (He admitted no more than five named categories in the animal kingdom, — class, order, family, genus, and species.)

As we have seen, Cuvier, Latreille, Rafinesque, and others, to some extent, used names ending in *-ides* and *-ini*; but the first

to fully recognize the advisability of using patronymic family names universally was William Kirby, who has not often received the credit for so doing, and is probably unknown to most in such connection. Nevertheless, in a note to his memoir on "Strepsiptera, a new Order of Insects proposed," he explicitly introduced this important feature in systematic terminology. He complained that Latreille's names "have not that harmony and uniformity of termination which is necessary to make them easily retained by the memory." Continuing, he added, "If we adopted a patronymic appellation for these sections, for instance, Coleoptera *Scarabæidæ*, Coleoptera *Staphylinidæ*, Coleoptera *Sphæridiadæ*, Orthoptera *Gryllidæ*, etc., it would be liable to no objection of this kind."

The suggestion thus made was heeded. The English naturalists (especially William Elford Leach and John Edward Gray) soon applied the method inculcated, and from them it has spread to the naturalists of every land; but the original impulse has been forgotten. For this reason I have recalled the memory of Kirby's work.

But it was long before the expediency of this procedure was universally recognized, and even yet there are dissentients. One objection was that the termination *-idæ* was not consistent with Latin words. Professor Agassiz was never reconciled to such names, and gave names of Greek origin the termination *-oidæ*, and those of Latin the ending *-inæ*. In his system, too, there was no distinction between families and subfamilies, both having terminations in consonance with the origin of the stems, and not the taxonomic value of the groups.

The endings *-idæ* and *-oidæ* have been often supposed to be identical, and even in highly esteemed dictionaries (as "The Imperial Dictionary of the English Language") the terminal element of family names ending in *-idæ* is derived from "εἶδος, resemblance." As already indicated, however, words so terminated should be considered as patronymics. But those ending in *-oidæ*, *-oidei*, and *-oidea* may be assumed to be direct components with εἶδος.

In answer to the objection (by Burmeister for example) that patronymic names are foreign to the genius of the Latin language, or at least of Latin prose, the fact that such a poet as Vergil has a large number shows that there is no pervading antagonism.

SUBFAMILY.

Next to the family, the term "subfamily" was the earliest, and has been the one most generally accepted of the groups now adopted. But the name itself was not used till long after "family" had come into general vogue. The chief subdivision of the family had been named tribe, "*tribu*," by Latreille, in 1806, and he continued to use that term. C. S. Rafinesque, in 1815, used the word subfamily, "*sous-famille*," for groups of the same relative rank as the "tribu" of Latreille, but gave generally descriptive names, with modified nominative plural endings (*e. g. Monodactylia*), although sometimes he named the group after the principal genus (*e. g. Percidia*). The subfamily is now generally recognized, and its ending rendered by *-inæ*, or more seldom *-ini* or *-ina*. This is rather a termination for Latin adjectives involving the idea of relation or pertinence.

But, as has been already urged, the language of nomenclature should not be bound by rules of strict philology. One of the most useful devices of scientific terminology is the establishment of terminations which indicate the nature or value of a group or relation to the group to which some entity belongs.

The chemist has his terminations in *-ates*, *-ides*, and *-gens*, and does not deem it incumbent to defend his usage or to abandon his system, because some one might object to the want of classical models. Nay, classical scholars themselves have recognized the legitimacy and usefulness of such a method.

The ending *-idæ* has been shown to have classical sanction for both Greek and Latin, *-inæ* has only classical sanction for Latin words, and there is one — *-oidea* or *-oideæ* — for which no models are to be found in either language. But the convenience of all those endings as indicative at once of the taxonomic value of each group far outweighs any objection to them from the philological side. We are now confronted with the groups having the *-oidea* ending.

SUPERFAMILY.

Experience has shown that for the exhibition of difference in value of various groups and characters, more than the generally accepted groups — families and subfamilies — are desirable. Groups above the family, in the generality of their characters,

had been frequently adopted. A quarter century ago, I searched for an available name and notation for such a group, and found that the groups which I wished to recognize were most like those that Dana had recognized in the Crustaceans, under the name of subtribe, and given the ending *-oidea.* But the term "tribe" had first been given and most generally used for a subdivision of the family, and consequently was ineligible for a group including the family. Other names had been given to such groups, but there were objections against them. In a communication to the American Association for the Advancement of Science (Volume XX.) I used a new name — superfamily — and the termination *-oidea*. The great advantage of the name was that it relieved the memory, and suggested at once what was meant by relation to a familiar standard — family. The term has been quite generally adopted, but there has been diversity of usage in the form of the names, *-oideæ* being frequently suffixed to the stem, and sometimes a descriptive name has been given. The only reason for the ending *-oidea* is that it was first used in such connection; *-oideæ* has the advantage (or disadvantage?) that it is in consonance with *-idæ* and *-inæ*. No provision has been made by the German Zoölogical Society for this category, their attention having been confined to family and subfamily nomenclature.[1]

OTHER GROUPS.

Time does not permit of the consideration of the other groups, — order, suborder, superorder, class, subclass, superclass, branch, etc. Nevertheless, a caveat is in order that there appears to be no reason why the principle of priority now so generally recognized for the subordinate groups should not prevail for the higher. Why should the name Amphibia disappear and Batrachia and Reptilia usurp its place? Amphibia is a far better name for the Batrachia, and in every way defensible for it. The name had especial relation to it originally, and it was first restricted to it as a class. Why should the names Sauria and Serpentes give place to Lacertilia and Ophidia? The first are

[1] "Die Namen von Familien und Unterfamilien werden fortan von dem gültigen Namen einer zu diesen Gruppen gehörigen Gattung gebildet, und zwar die der Familien durch Anhängen der Endung *idæ* (Plural von *ides* [gr. εἴδης] masc. gen.), die der Unterfamilien durch Anhängen der Endung *inæ* (fem. gen.) an den Stamm des betreffenden Gattungsnamens." Regeln . . . von der Deutsch. Zool. Ges., § 28.

names familiar to all, and correctly formed; the last are, at least, strangely framed. Why should not Meantia be adopted as an ordinal name, by those who regard the Sirenids as representatives of a distinct order, as did Linnæus? Why should not the ordinal names Bruta, Feræ, Glires, and Cete prevail over Edentata, Carnivora, Rodentia, and Cetacea? If the rules formulated by the various societies are applied to those groups, the earlier names must be revived.

COMPLAINTS OF INSTABILITY OF NOMENCLATURE.

Frequent are the laments over the instability of our systematic nomenclature; bitter the complaints against those who change names. But surely such complaints are unjust when urged against those who range themselves under laws. We are forcibly reminded by such complaints of the ancient apologue of the wolf and the lamb. The stream of nomenclature has indeed been much muddied, but it is due to the acts of those who refused to be bound by laws or reason. The only way to purify the stream is to clear out all the disturbing elements. In doing so, mud that has settled for a time may be disturbed, but this is at worst anticipating what would have inevitably happened sooner or later. We are suffering from the ignorance or misdeeds of the past. In opposing the necessary rectifications and the enforcement of the laws, extremes may meet; conservatives and anarchists agree. But the majority may be depended upon in time to subscribe to the laws, and the perturbed condition will then cease to be.

It is unfortunate that our nomenclature should have been so wedded to systematic zoölogy, and devised to express the different phases of our knowledge or understanding of morphological facts. Even under the binomial system, the disturbing element might have been made much less than it is. The genera of Linnæus recognized for the animal kingdom were generally very comprehensive; sometimes, as in the case of *Petromyzon*, *Asterias*, and *Echinus*, answering to a modern class; sometimes, like *Testudo*, *Rana*, *Cancer*, *Scorpio*, *Aranea*, *Scolopendra*, and *Julus*, to a modern order, or even more comprehensive group, and rarely, among Vertebrates, to a group of less than family value. The usage of Linnæus for the animal kingdom was very different from that for the vegetable kingdom. If the successors of Linnæus had been content to take genera of like high rank (equiva-

lent to families, for example), and give other names to the subdivisions (or subgenera) of such genera, which, to use the language of Linnæus, should be mute, less change would have subsequently resulted. But (Linnæus himself leading) his successors successively divided a genus, gradually accepting a lower and lower standard of value, till now a genus is little more than a multiform or very distinct isolated species. Yet the change has been very gradual. It began by taking a comprehensive group, recognizing that the differences between its representatives were greater than those existing between certain genera already established, and therefore the old genus was split up; or it was perceived that the characters used to define a genus were of less systematic importance than others found within the limits of the old genus, and, to bring into prominence such a truth, the genus was disintegrated. The process often repeated, and from successively contracted bases, has led to the present condition.

The existing system of restricted genera, however, is too firmly fixed to revert back to a method that might have been, and which indeed Cuvier attempted to introduce by his revised Linnæan genera and their subgenera. The best thing to do now is to accept the current system, purified as much as possible by judicious and inexorably applied laws. Doubtless in the distant future a less cumbrous and changeable system of notation will be devised, but in the mean time we had best put up with the present, inconvenient though it be.

PAPERS READ.

TUESDAY, AUGUST 25.

ON THE ENTOMOLOGICAL RESULTS OF THE EXPLORATION OF THE BRITISH WEST INDIA ISLANDS BY THE BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE. By L. O. HOWARD, Dept. of Agriculture, Washington, D. C.

WARNING COLORS, PROTECTIVE COLORATION, AND PROTECTIVE MIMICRY. By F. M. WEBSTER, Wooster, Ohio.

ON LIFE ZONES IN WEST VIRGINIA. By A. D. HOPKINS, Exper. Station, Morgantown, W. Va.

ON THE VARIATION OF CERTAIN SPECIES OF NORTH AMERICAN ODONATA. By D. S. KELLICOTT, Columbus, Ohio.

A CASE OF EXCESSIVE PARASITISM. By L. O. HOWARD, Dept. of Agriculture, Washington, D. C.

NOTES ON THE OCCURRENCE OF DRAGONFLIES IN OHIO IN 1896. By D. S. KELLICOTT, Columbus, Ohio.

SCYLLARUS AND ANEMONIA — A CASE OF SEMI-COMMENSALISM. By EDWARD L. RICE, Middletown, Conn.

WEDNESDAY, AUGUST 26.

NOTES UPON CORDYLOPHORA. By PROF. C. W. HARGITT, Syracuse, N. Y.

MODIFICATION OF the BRAIN DURING GROWTH. By SUSANNA PHELPS GAGE, Ithaca, N. Y. (Published in *American Naturalist*, vol. xxx. p. 836.)

NOTE ON THE MEMBRANOUS ROOF OF THE PROSENCEPHAL AND DIENCEPHAL OF GANOIDS. By B. F. KINGSBURY, Ithaca, N. Y.

STRUCTURE AND MORPHOLOGY OF THE OBLONGATA OF FISHES. By B. F. KINGSBURY, Ithaca, N. Y.

DIFFERENTIATION OF WORK IN ZOÖLOGY — IN SECONDARY SCHOOLS. By WILLIAM ORR, Jr., Springfield, Mass.

FIELD WORK AND ITS UTILITY. By JAS. G. NEEDHAM, Galesburg, Ills.

APPENDAGES OF AN INSECT LARVA. By AGNES M. CLAYPOLE, Wellesley, Mass.

THURSDAY, AUGUST 27.

THE PERITONEAL EPITHELIUM IN AMPHIBIA. By ISABELLA M. GREEN, Ithaca, N. Y.

THE HEART OF THE LUNGLESS SALAMANDERS OF CAYUGA LAKE. By GRANT S. HOPKINS, Ithaca, N. Y. (Published in *American Naturalist*, vol. xxx. p. 829.)

OBSERVATIONS ON THE CHAMELEON, ANOLIS PRINCIPALIS. By Rev. GEORGE V. REICHEL, Brockport, N. Y.

ENERGY IN ANIMAL NUTRITION. RELATIVE EFFICIENCY OF ANIMALS AS MACHINES. By Prof. MANLY MILES, Lansing, Mich. (Published in *American Naturalist*, vol. xxx. p. 784.)

SOME ABNORMAL CHICK EMBRYOS. By Prof. C. W. HARGITT, Syracuse, N. Y.

ON A PECULIAR FUSION OF THE GILL-FILAMENTS IN CERTAIN LAMELLIBRANCHS. By EDWARD L. RICE, Middletown, Ct.

EXPERIMENTS UPON HETEROMORPHOSIS AND REGENERATION. By Prof. C. W. HARGITT, Syracuse, N. Y.

THE PENIAL STRUCTURES OF THE SAURIAS. By Prof. EDWARD D. COPE, Philadelphia, Pa. (Published by abstract in *Science*, N. S., iv. 561.)

THE RELATIONSHIPS OF THE NORTH AMERICAN FAUNA. By Prof. THEODORE GILL, Columbian University, Washington, D. C.

NOTE. — The paper on THE BONE-FISSURE AT PORT KENNEDY, by EDWARD D. COPE, was given as a public lecture, *Thursday evening*.

The paper by FRED K. MIXER, on A NEW FISH FAUNA OF THE WATERLIME, was withdrawn to be read in Section E.

Section adjourned Thursday Evening.

SECTION G.

BOTANY.

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ADDRESS

BY

VICE-PRESIDENT

NATHANIEL LORD BRITTON,

CHAIRMAN OF SECTION G.

BOTANICAL GARDENS.

ORIGIN AND DEVELOPMENT.

THE cultivation of plants within small areas for their healing qualities by the monks of the Middle Ages appears to have been the beginning of the modern botanical garden, although these mediæval gardens doubtless took their origin from others of greater antiquity. Botanical gardens were thus primarily formed for purely utilitarian purposes, although the æsthetic study of planting and of flowers must doubtless have appealed to their owners and visitors. Their function as aids in scientific teaching and research, the one which at present furnishes the dominating reason for their existence, did not develop much, if at all, before the sixteenth century, and prior to the middle of the seventeenth century a considerable number existed in Europe in which this function was recognized to a greater or less degree, of which those at Bologna, Montpellier, Leyden, Paris, and Upsala were perhaps the most noteworthy. The ornamental and decorative taste for planting had meanwhile been slowly gaining ground, as well as the desire to cultivate rare or unusual species, and during the eighteenth century attained a high degree of development. Many persons of wealth and influence fostered this taste and became, through the employment of men skilled in botany and horticulture, generous patrons of science. The world was searched for new and rare plants, which were brought home to Europe for cultivation, and many sumptuous volumes, describing and delineating them, were published, mainly through the same patronage. The older gardens were essentially

private institutions, but as the rights of the people became more and more recognized, many existing establishments and an increasing number of newly founded ones became, to a greater or less extent, open to the public, either through an admittance fee or without charge. The four main elements of the modern botanical garden have thus been brought into it successively: —

1. The utilitarian or economic.
2. The æsthetic.
3. The scientific or biologic.
4. The philanthropic.

These four elements have been given different degrees of prominence, depending mainly upon local conditions, some gardens being essentially æsthetic, some mainly scientific, while in our public parks we find the philanthropic function as the underlying feature, usually accompanied by more or less of the æsthetic and scientific.

The Economic Element. — In the broadest extension of this department of a botanical garden there might be included, to advantage, facilities for the display and investigation of all plants directly or indirectly useful to man, and their products. This conception would include forestry, pharmacognosy, agriculture, pomology, pathology, and organic chemistry, and, in case the management regards bacteria as plants, bacteriology.

The display of the plants may be effected by growing such of them as will exist without protection in the locality in a plot, more or less individualized, commonly known as the Economic Garden, while those too tender for cultivation in the open are grown in the greenhouses, either in a separate house or section, or scattered through the several houses or sections, in the temperatures best adapted to their growth. The display of plant products, best accompanied by mounted specimens of the species yielding them, by photographs and by plates, is accomplished by the Economic Museum, where these are arranged in glass or glass-fronted cases, suitably classified and labelled. It is believed that the most useful results are obtained by arranging this museum by the products themselves, and thus not in biologic sequence, but by bringing together all drugs, all fibres, all woods, all resins; where the same product is used in more than one industry the exhibit may be duplicated, more or less modified, without disadvantage.

The investigation of economic plants and their products is accomplished through the Scientific Department, and few valuable results

can be reached unless the scientific equipment is well developed. The two departments must work conjointly, both on account of the necessity of knowing just what species is under investigation, its structure, distribution, and literature, and in order that the most approved and exact methods may be used in the research. Any idea that the scientific element can be dispensed with in connection with economic studies is palpably untenable.

Teaching and research in agriculture, pomology, and plant pathology are so well organized in America, through our National Department of Agriculture and our numerous agricultural colleges and schools, that there is no great necessity for providing elaborate equipments for those branches in botanical gardens. But in case the endowment of a garden were sufficiently large to enable them to be successfully prosecuted, in addition to more necessary work, there can be no doubt that important additions to knowledge would be obtained. On the other hand, no such liberal allowances have been made with us for forestry or pharmacognosy, and research and instruction in these sciences must prove of the greatest benefit to the country.

The Æsthetic Element. — The buildings, roads, paths, and planting of a botanical garden should be constructed and arranged with reference to tasteful and decorative landscape effect. The possibilities of treatment will depend largely upon the topographical character of the area selected and the natural vegetation of the tract. The buildings required are a fire-proof structure or structures for museum, herbarium, libraries, laboratories, and offices; a glass house with compartments kept at several different temperatures for exhibition, propagation, and experimentation, or several separate glass houses; and to these will usually be added dwelling-houses for some of the officers, a stable, and other minor buildings. The character, number, and sizes of the buildings generally depend on financial considerations. In placing the structures intended for the visiting public, considerations of convenient access, satisfactory water supply, and the distribution of crowds must be borne in mind, in connection with the landscape design. The planting should follow, as nearly as possible, a natural treatment, except immediately around the larger buildings and at the entrances, where considerable formality is desirable for architectural reasons. It is especially desirable that as much natural treatment as possible should be given to the areas devoted to systematic planting, — her-

baceous grounds, fruticetum, arboretum. The rectilinear arrangement of plant beds found in most of the older gardens has become abhorrent to landscape lovers, and the sequence of families desired can usually be quite as well obtained by means of curved-margined groups.

The cultivation of decorative plants, and especially the fostering of a taste for them, and the bringing of unusual or new species to attention and effecting their general introduction, are important functions of a botanical garden. For the accurate determination of these plants, information concerning their habits and structure, and suggestions regarding the conditions of their growth, the æsthetic side must rely on the scientific.

The Scientific or Biologic Element.—The important relations of the scientific department to the economic and æsthetic have already been alluded to. The library, herbarium, museums, and laboratories are the sources whence exact information regarding the name, structure, habits, life processes, and products of plants are derived, and they are the more useful as they are the more complete and thoroughly equipped. It is practically impossible for any one library to have all the literature of botany and related sciences, any one herbarium to possess an authentic and complete representation of all species of plants, or any one museum to be thoroughly illustrative; absolute perfection along these lines cannot be obtained, but the more closely it is approximated the better the results. The research work of the scientific department should be organized along all lines of botanical inquiry, including taxonomy, morphology, anatomy, physiology, and paleontology, and the laboratories should afford ample opportunities and equipment for their successful prosecution.

The arrangement of the areas devoted to systematic planting, and the proper labelling of the species grown, are important duties of the scientific department. The sequence of classes, orders, and families is usually made to follow some "botanical system." It is highly desirable that this should be a system which indicates the natural relations of the families, as understood at the time the garden is laid out, and be elastic enough to admit of subsequent modification as more exact information relative to those relationships is obtained. The weight of present opinion is overwhelmingly in favor of an arrangement from the more simple to the more complex, and this will apply not only to the systematic plantations, but to the systematic museum and the herbarium.

The scientific possibilities of a botanical garden are the greater if an organic or co-operative relationship exists between it and a university, thus affording ready facilities for information on other sciences.

The Philanthropic Element. — A botanical garden operates as a valuable philanthropic agency, both directly and indirectly. Its direct influence lies through its affording an orderly arranged institution for the instruction, information, and recreation of the people, and it is more efficient for these purposes than a park, as it is more completely developed and liberally maintained. Its indirect, but equally important, philanthropic operation is through the discovery and dissemination of facts concerning plants and their products, obtained through the studies of the scientific staff and by others using the scientific equipment.

NUMBER AND DISTRIBUTION OF BOTANICAL GARDENS.

There are somewhat over 200 institutions denominated botanical gardens, but only a few of them meet the requirements of the foregoing sketch. Some are essentially pleasure parks, with the plants more or less labelled; most of them pay some attention to taxonomy and morphology, many to economic botany, while a small number are admirably equipped in all branches of the science.

I have drawn freely on Professor Penhallow's first annual report of the Montreal Botanical Garden, published in 1886, for the following approximate statement of the number in different countries: —

Algeria, 1.
Australia, 5.
Austro-Hungary, 13.
Belgium, 5.
Brazil, 2.
Canada, 1.
Canary Islands, 1.
Cape of Good Hope, 3.
Ceylon, 1.
Chili, 1.
China, 1.
Cochin China, 1.
Denmark, 2.
Ecuador, 1.
Egypt, 1.
France, 22.
Germany, 36.
Great Britain and Ireland, 12.
Greece, 1.
Guatemala, 1.
Guiana, 1.
Holland, 4.
India, 7.
Italy, 23.
Japan, 1.
Java, 1.
Malta, 1.
Mauritius, 1.

Natal, 1.
New Zealand, 1.
Norway, 1.
Peru, 1.
Philippine Islands, 1.
Portugal, 3.
Reunion, 1.
Roumania, 2.
Russia, 16.
Servia, 1.
Siberia, 1.
Spain, 2.
Straits Settlements, 1.
Sweden, 6.
Switzerland, 4.
Tasmania, 1.
United States, 10.
West Indies, 6.

NOTES ON SOME FOREIGN GARDENS.

1. Buitenzorg, Java. This is the largest botanical garden, occupying some 1,100 acres, at altitudes from sea level to about 6,000 feet. It was founded by the Dutch government in 1817, and has been well supported. Affording as it does highly favorable conditions for the growth of tropical and subtropical plants under natural conditions, it has yielded most important results, especially in taxonomy and plant physiology, many of which have been published in the ten large volumes of its "Annales."

2. The Royal Botanic Gardens at Kew are situated on the south bank of the Thames, about six miles west of Hyde Park Corner. They are reached by several railway routes, the time from Charing Cross being about forty minutes, by steamer, and by omnibus lines. The present area of the gardens is about 260 acres, an addition having been made during the past year. These world-famed gardens originated in the exotic garden of Lord Capel, in 1759. In 1840 they were adopted as a national establishment and opened as a public park. The botanic garden proper occupies about seventy acres, and the remainder is given to arboretum and pleasure grounds. There are two main greenhouses: 1. The palm house, 362 feet long, the central dome rising 66 feet; 2. The temperate house, of which the central portion is 212 feet long, 137 feet broad, and about 60 feet high, flanked by wings which give a total length of about 580 feet, the whole covering between one and one and one half acres of ground. There are also fourteen other houses, grouped in two ranges and more or less connected, given to special collections. There are three botanical museums: 1. Devoted to economic products; 2. to miscellaneous products; 3. to timbers. There is also a large museum hall given to the exhibition of floral paintings by the late Marienne North. There is a small laboratory equipped for

research in physiological botany. The herbarium and library occupy the old palace of the King of Hanover, near the main entrance to the garden, and they are the largest and most complete in the world. The herbaceous ground is planted in long parallel beds, and contains several thousand species. The arboretum is thoroughly illustrative of all trees that will grow in the open at Kew, and the shrubs are, for the most part, cultivated in areas by themselves. There are numerous special features, such as the rock garden, the bamboo garden, and the American garden.

The research work of Kew is principally economic and taxonomic. Around it centre the twenty-four botanical gardens and botanical stations of the British colonies, which are manned chiefly by men who have studied or worked at Kew. The principal publications at present emanating from Kew are: —

1. The Kew Bulletin of Miscellaneous Information.
2. Hooker's Icones Plantarum.
3. The Continuation of Hooker's Flora of India.
4. The Continuation of the Flora of Tropical Africa.
5. Annual Reports.
6. The Index Kewensis.

The monographs and separate writings of its staff of scientific men are too numerous to review at this point.

3. The Royal Botanical Garden of Berlin is situated in the south-western part of the city, but a project for moving it out into the country is now being seriously considered. The palm house reaches a height of about ninety feet, being the highest one yet constructed, and too high for satisfactory operation. The botanical museum is very extensive, and has series of economic, systematic, and archæological collections. The herbarium is one of the largest in the world. The systematic beds are arranged on a strictly modern sequence, and portions of the garden are devoted to plant geography and plant biology. The arboretum is not extensive. Among special features may be mentioned the alpine garden and the collections of Cacti. The garden is an institute of the University, where the principal laboratories are situated. There is also an institute of plant physiology, with a small separate garden. The official publications of the Berlin Garden are the "Notizblatt" and annual reports. A series of volumes of "Jahrbücher" was issued some years ago. The publications of the garden staff are voluminous, and cover all lines of botanical inquiry.

4. The long established "Jardin des Plantes," the gardens of the Museum of Natural History at Paris, are situated in the heart of the city, fronting on the Seine. The conservatories are grouped near the main museum building, at one end of the grounds, are very large, and contain a great variety of plants. The botanical library, laboratories, and the enormous herbarium are in a separate older building. The systematic beds are arranged in rows; owing to the limited size of the area devoted to them they are much crowded, but contain a splendid assortment of species. But little space is given to trees; there are, however, some famous specimens. Many valuable contributions to the literature of botany along all its lines have emanated from this grand institution for over one hundred years, published for the most part in the "Annales" and "Archives" of the Museum of Natural History, and in the Bulletin of the Botanical Society of France.

5. The Botanical Garden of the University of Vienna was established about 1754, and is located in the heart of the city. There are here very important and extensive museums, herbaria, and libraries, and one large fine greenhouse. The systematic plantations occupy the larger portion of the tract, and special areas are devoted to the cultivation of medicinal and other economic plants, to an arboretum of native trees, and to groups illustrating plant geography. The garden and associated laboratories provide equipment for the prosecution of all lines of botanical research.

6. The Botanical Garden of Geneva was founded in 1817, and is situated in the heart of the city, near the University. There are two small greenhouses, a very large and important herbarium and library, and a small museum. The laboratories of the University are extensive and well equipped, affording capital facilities for work along all lines of botanical investigation. The De Candolle herbarium and library, and the Boissier herbarium and library, which are near by, afford, in connection with the collections of the garden, unsurpassed facilities for taxonomic study.

7. The Royal Botanic Garden of Edinburgh covers about sixty acres, of which about one half was added to the older portion some twelve years ago; there are possibilities of still further enlargement. The main greenhouses have a frontage of about two hundred feet, the palm house rising some seventy feet, and there are six small special houses. The botanical museum, lecture room, and laboratories are in one building, the large herbarium and library in

another. The systematic plantations of herbaceous species are extensive, the rock garden being an especially strong feature. The development of arboretum and fruticetum in the newer portion of the tract has made good progress. The institution is in intimate relationship with the University, nearly all the instruction in botany being given at the garden. The research work has been extensive, along taxonomic, morphologic, and physiologic lines.

8. The Royal Botanic Garden of Dublin, situated at Glasnevin, just without the city, was founded through the influence of the Right Honorable and Honorable Dublin Society, in 1790, was for many years supported by this Society with the aid of government grants, and was transferred to the Science and Art Department in 1877. It includes about forty acres of undulating land, bounded to the north by the small river Tolka. There are eight greenhouses, most of them rather old, but containing a valuable collection. There is a small botanical museum and herbarium. The systematic herbaceous plantations are irregularly shaped beds, arranged in a somewhat radial manner. The arboretum and fruticetum occupy about one half of the area.

9. The Brussels Botanical Garden lies in the heart of the city and embraces not more than ten acres of land, of which about one half is given to arboretum. The greenhouses are large but old. There is a very extensive herbarium and library. The systematic beds are arranged as quadrants of a circle, separated by concentric and radial paths. Special areas are devoted to ornamental and economic plants. Owing to the restricted size of the area available a very dense grouping of plants is necessitated. The research work accomplished here has been mainly taxonomic. The Botanical Society of Belgium has its headquarters at the garden.

10. The Imperial Botanical Garden at St. Petersburg is in close affiliation with the Academy of Sciences and the University. There is here a famous herbarium, a large botanical library and museum, and commodious and well stocked greenhouses. The garden publishes "Acta," and many researches prosecuted there are printed in the Bulletin and Memoirs of the Imperial Academy.

11. The Royal Botanic Garden of Trinidad, situated at Port of Spain, was established in 1818, and now occupies about sixty-three acres, with some outlying plantations. There is a vast collection of tropical plants in cultivation, an extensive botanical library and herbarium, and a small laboratory. The garden publishes "Annual

Reports" and "Bulletin," dealing especially with topics of economic application.

12. The Botanical Department of Jamaica, West Indies, operates extensive gardens at Kingston, smaller ones at Castleton, and the several large Cinchona plantations. The scientific collections and library are valuable. The department publishes "Annual Reports" and "Bulletin," especially devoted to economic botany.

13. McGill University, at Montreal, Quebec, carries on a small botanical garden in connection with its laboratories. The Montreal Botanic Garden, begun in 1885 on about seventy-five acres of ground in Mount Royal Park, was soon abandoned, owing to political complications.

14. Among other foreign gardens of which mention must be made, and of which a description would be interesting if our time allowed, are those at Munich, Würzburg, Tübingen, Stockholm, Copenhagen, Upsala, Zurich, Ceylon, Calcutta, and Oxford.

BOTANICAL GARDENS IN THE UNITED STATES.

The first botanical garden established in America was begun by John Bartram in Philadelphia, in 1728. In it he placed a considerable number of plants obtained in the course of his extensive travels. The plot still remains, including the family homestead, somewhat modified, and it is a pleasure to know that it will be preserved as public ground.

André Michaux, in the latter part of the last century, planted gardens at Charleston, S. C., and New Durham, N. J., but they were essentially nurseries from which he sent seeds and plants to Europe.

In the year 1801 Dr. David Hosack, then Professor of Botany and Materia Medica in Columbia College, purchased twenty acres of ground in New York City, and called it the Elgin Botanic Garden; in this tract he accumulated, with great labor, during the next ten years, a very large and valuable collection of plants. The institution was transferred to the State of New York, through an Act of the Legislature, in 1810, and was then known as the Botanic Garden of the State of New York. It was subsequently granted to Columbia College. Funds for its maintenance were not provided, however, and it was ultimately abandoned. Two catalogues of its plants were issued by Dr. Hosack, one in 1806, and another in 1811.

The condition of botanical gardens in America at that time is indicated by the following note in Dr. Hosack's catalogue of 1806: —

"I learn, with pleasure, that a Botanic Garden is proposed to be established near Boston, and connected with the University of Cambridge. The Legislature of Massachusetts, with a munificence which does them honor, have granted, for this purpose, a tract of land, the value of which is estimated at thirty thousand dollars; and several individuals have evinced their liberality and love of science by voluntary subscriptions, to the amount of fifteen thousand dollars, towards the establishment and support of that institution. Another is also begun at Charleston, S. C., and a third is contemplated in New Jersey, in connection with the College of Princeton."

In the year 1824 there was published at Lexington, Ky., the "First Catalogues and Circulars of the Botanical Garden of Transylvania University at Lexington, Ky., for the year 1824," by W. H. Richardson, M. D., President of the Board of Managers, and C. S. Rafinesque, Ph. D., Secretary. This rare pamphlet, which is not recorded in Dr. Call's very complete life and writings of Rafinesque, is of twenty-four pages, and is printed alternately in English and French. It is essentially an appeal for plants and material for the garden, and a list of species that it could furnish to kindred institutions. This garden was evidently short-lived, inasmuch as in Rafinesque's "Neogenyton" of the following year, 1825, he remarks, "I mean, therefore, to indicate and propose in this small essay, many of the numerous new genera of plants detected or ascertained, some of which were indicated last year, 1824, in the Catalogue of the botanical garden which I have tried in vain to establish in Lexington."

The principal gardens at present operated and in course of development in the United States are as follows: —

1. The Botanic Garden of Harvard University, at Cambridge, Mass., founded in 1805. There are about seven acres of land under cultivation, a small greenhouse, and a famous herbarium and library, from which have flowed during the past forty years voluminous and invaluable contributions to taxonomy and morphology, especially of North American plants. There is also a small morphologic laboratory. The main laboratories and museums connected with the institution are situated in other of the Harvard buildings, a short distance away. The system of garden, libraries, museum, laboratories, and herbaria operated by Harvard College is one of

the most complete in existence. It is hard to say, indeed, in what respect it is not ideal, except in the rather wide distance separating the several elements, and the small amount of land available for planting.

2. The Arnold Arboretum of Harvard University, at Jamaica Plain, Mass., was founded through a bequest of $100,000, made about 1870, by Mr. James Arnold, of Providence, R. I., to three trustees, to be used for the improvement of agriculture or horticulture. The trustees wisely determined to devote it to forestry and dendrology, and effected co-operative agreements with Harvard College and the city of Boston, which have now given us the greatest tree museum in existence, freely open to the visiting public. The planted area is about one hundred and sixty acres, and will be materially increased in size. A small museum, library, and herbarium building has been erected near the main entrance. The great "Silva of North America" and the journal "Garden and Forest" are noteworthy publications from this noble institution.

3. The Botanic Gardens of the United States Department of Agriculture, at Washington, have an extensive range of greenhouses and a large tract of land under cultivation. The herbarium of the department, now deposited with the United States National Museum, is very large, and is at present increasing more rapidly than any other in America. There is a somewhat effective working library, which greatly needs material enlargement, and several poorly located and equipped laboratories, in which a vast amount of important investigation is being accomplished, under very unfavorable conditions, which urgently demand improvement. Publications include: Bulletin of the Botanical Division, Bulletin of the Division of Forestry, Bulletin of the Division of Plant Pathology and Physiology, Contributions from the United States National Herbarium, Year-Book of the United States Department of Agriculture, and circulars of the several divisions.

4. The Missouri Botanical Garden, at St. Louis, Mo., was established in 1889, through the provisions of the will of Mr. Henry Shaw, who for over thirty years previously had been bringing together material for it on the land about his residence, which was known as Shaw's Garden. There were in all some six hundred and seventy acres devised to the institution under the will of the generous and philanthropic founder, and from the income yielded by

much of this land, not nearly all the area being required for garden purposes, the institution derives its large maintenance fund, which will certainly be greatly increased as the land becomes more valuable, and will supply an income sufficient to operate the institution in the most effective manner. There are several greenhouses, a very large and valuable herbarium and library, while the laboratories of the Shaw School of Botany, at Washington University, are in close relationship to the garden. Much important research, principally taxonomic, has been prosecuted. Publications consist of seven volumes of Annual Reports, and nine "Contributions from the Shaw School of Botany."

5. The Botanical Garden of the Michigan Agricultural College was begun in 1877. There are now about three acres under high cultivation, exclusive of the arboretum and decorative grounds, which together cover several acres. There are several small greenhouses, an herbarium of about sixty thousand specimens, a good botanical library, and extensive, well equipped laboratories.

6. The University of California, at Berkeley, has a botanical garden of several acres, established some years ago, in which a large number of plants are grown. It furnishes a valuable adjunct to the work of the botanical department, which has well appointed laboratories, a working library, and a large herbarium.

7. The University of Pennsylvania has recently established a garden of about three acres in the immediate vicinity of its building, in Philadelphia, and has many species under cultivation. The extensive and well appointed laboratories of its School of Biology, good library facilities, and a small herbarium afford capital opportunity for research, especially in physiology and morphology.

8. Smith College, at Northampton, Mass., has also recently established a botanical garden, on the campus.

9. The Buffalo Botanical Garden, in South Park, Buffalo, N. Y., was commenced in 1893, and has since made rapid and encouraging progress. A small range of greenhouses has been built, and others are planned. A beginning has been made in accumulating a library and herbarium, and much permanent planting has been accomplished.

10. The New York Botanical Garden. The establishment of the New York Botanical Garden was authorized by the Legislature in 1891, and the enabling act was amended in 1894. The enterprise was inaugurated and the legislation procured by a committee of the

Torrey Botanical Club, appointed in 1889. The Act of Incorporation provided that, when the corporation created should have raised or secured by subscription a sum not less than $250,000, the Commissioners of Public Parks were authorized to set apart and appropriate a portion of one of the public parks, not exceeding two hundred and fifty acres, and the Board of Estimate and Apportionment was authorized to issue bonds, aggregating the sum of $500,000, for the construction and equipment, within the grounds, of the necessary buildings. The subscription of $250,000 required by the Act of Incorporation was completed in June, 1895, and the Commissioners of Public Parks, in the following month, formally appropriated two hundred and fifty acres of the northern part of Bronx Park for the purposes of the Garden. Since that time the preparation of plans for the development of the tract has been steadily progressing, including designs for the museum building and a large horticultural house. This planning is still in progress, in charge of a commission of architects, engineers, gardeners, and botanists, who will complete their work within a short time, and be ready to submit a complete scheme to the Board of Managers during the coming autumn. Meanwhile, much preliminary work has been accomplished in clearing the ground, in grading, in the planting of borders, in the establishment of an extensive nursery, and in the accumulation of herbarium, museum, and library material. Through a co-operative agreement entered into with Columbia University, the herbarium and botanical library of the University will be deposited with the Garden, and most of the research and graduate work of the University in botany will be carried on in the Museum Building.

The endowment fund has been materially increased, and about four hundred and thirty persons have become annual members of the Garden, contributing ten dollars a year each to its support. The publication of a Bulletin has been commenced by the issue, in April, of the first number of Volume I.

PAPERS READ.

BEGINNING TUESDAY, AUGUST 25.

DIRECTIVE FORCES OPERATIVE IN LEAF ROSETTES. By R. N. DAY, University of Minnesota, Minneapolis. (To be published in *Minnesota Botanical Studies.*)

ON THE BACTERIAL FLORA OF CHEDDAR CHEESE. By Prof. H. L. RUSSELL University of Wisconsin, Madison. (To be published in *13th Report Wisconsin Agrl. Expt. Station.*)

THE STIGMA AND POLLEN OF ARISÆMA. By Prof. W. W. ROWLEE, Cornell University, Ithaca, N. Y. (Published in *Bulletin of Torrey Botanical Club.*)

STUDIES IN NUCLEAR PHENOMENA, AND THE DEVELOPMENT OF THE ASCOSPORES IN CERTAIN PYRENOMYCETES. By MARY A. NICHOLS, Huntington, Indiana. (Published in *Botanical Gazette.*)

ON THE STEM ANATOMY OF CERTAIN ONAGRACEÆ. By FRANCIS RAMALEY, University of Minnesota, Minneapolis.

ON CRATÆGUS COCCINEA AND ITS SEGREGATES. By Dr. N. L. BRITTON, Director Botanical Garden, New York City.

STRUCTURES OF THE EMBRYO-SAC. By Prof. J. M. COULTER, University of Chicago. (To be published in *Botanical Gazette.*)

NOTES ON THE GENUS AMELANCHIER. By N. L. BRITTON, Director Botanical Garden, New York City.

SOME CYPERACEÆ NEW TO NORTH AMERICA, WITH REMARKS ON OTHER SPECIES. By N. L. BRITTON, Director Botanical Garden, New York City.

ON THE CARDAMINES OF THE C. HIRSUTA GROUP. By N. L. BRITTON, Director Botanical Garden, New York City.

ON THE FORMATION AND DISTRIBUTION OF ABNORMAL RESIN DUCTS IN CONIFERS. By Dr. ALEX. P. ANDERSON, University of Minnesota, Minneapolis. (To be published in *Forst. Naturwissenschaftliche Zeitschrift*, München.)

ON AN APPARENTLY UNDESCRIBED CASSIA FROM MISSISSIPPI. By C. L. POLLARD, U. S. National Museum, Washington, D. C. (To be published in *Bulletin of the Torrey Botanical Club.*)

NOTES ON THE FAMILY PEZIZACEÆ OF SCHRÖTER. By ELIAS J. DURAND, Cornell University, Ithaca, N. Y.

A bacterial disease of the squash bug (Anasa tristis). By B. M. Duggar, Cornell Univ. Agrl. Expt. Station, Ithaca, N. Y.

Grasses of Iowa. By Prof. L. H. Pammel, Iowa Agricultural College, Ames, Iowa.

A contribution to our knowledge of the relation between growth and turgor. By Dr. Edwin B. Copeland, Monroe, Wisconsin.

The relation between the genera Polygonella and Thysanella, as shown by a hitherto unobserved character. By John K. Small, Columbia University, New York City.

An apparently undescribed species of Prunus from Connecticut. By John K. Small, Columbia University, New York City.

The flora of the summits of King's Mountain and Crowder's Mountain, North Carolina. By John K. Small, Columbia University, New York City.

Rheotropism and the relation of response to stimulus. By Prof. F. C. Newcombe, University of Michigan, Ann Arbor, Mich.

Some adaptation of shore plants to respiration. By Hermann von Schrenk, Washington University, St. Louis, Mo.

A comparison of the flora of Erie County, Ohio, with that of Erie County, New York. By E. L. Moseley, Ohio State Academy of Science, Sandusky, Ohio.

Sporophyll-transformation in dimorphic ferns. By Prof. George F. Atkinson, Cornell University, Ithaca, N. Y.

The significance of the compound ovary. By Prof. C. E. Bessey, University of Nebraska, Lincoln, Nebraska.

The influence of rainfall upon leaves. By Prof. D. T. McDougal, University of Minnesota, Minneapolis.

The curvature of tendrils. By Prof. D. T. McDougal, University of Minnesota, Minneapolis. (To be published in *Annals of Botany*, Sept., 1896.)

Relation of the growth of leaves to the carbon dioxide of the air. By Prof. D. T. McDougal, University of Minnesota, Minneapolis. (To be published in *Journal of the Linn. Society*, London.)

A comparative study of the development of some anthracnoses in artificial cultures. By Bertha Stoneman, Lakewood, N. Y.

The habits of the rarer ferns of Alabama. By Prof. L. M. Underwood, Columbia University, New York City. (To be published in *Botanical Gazette*.)

Notes on the allies of the sessile Trillium. By Prof. L. M. Underwood, Columbia University, New York City.

DISTRIBUTION OF THE SPECIES OF GYMNOSPORANGIUM IN THE SOUTH. By Prof. L. M. UNDERWOOD, Columbia University, New York City, and Prof. F. S. EARLE, Alabama Polytechnic Institute, Auburn, Ala. (To be published in *Botanical Gazette.*)

NOTES ON THE PINE-INHABITING SPECIES OF PERIDERMUM. By Prof. L. M. UNDERWOOD, Columbia University, New York City, and Prof. F. S. EARLE, Alabama Polytechnic Institute, Auburn, Ala. (Published in *Bulletin of Torrey Botanical Club.*)

THE TERMINOLOGY OF REPRODUCTION AND OF REPRODUCTIVE ORGANS. By Prof. C. R. BARNES, University of Wisconsin, Madison, Wis.

WHAT IS THE BARK? By Prof. C. R. BARNES, University of Wisconsin, Madison, Wis.

THE DEVELOPMENT OF THE VASCULAR ELEMENTS IN THE PRIMARY ROOT OF INDIAN CORN. By Prof. W. W. ROWLEE, Cornell University, Ithaca, N. Y. (To be published in *Bulletin of Torrey Botanical Club.*)

SOME REMARKS ON CHALAZOGAMY. By Prof. J. M. COULTER, University of Chicago. (To be published in *Botanical Gazette.*)

CERES-PULVER: JENSEN'S NEW FUNGICIDE FOR THE TREATMENT OF SMUTS. By Prof. W. A. KELLERMAN, Ohio State University, Columbus, Ohio.

PARTHENOGENESIS IN THALICTRUM FENDLERI. By DAVID F. DAY, Buffalo, N. Y.

WHAT SHOULD CONSTITUTE A TYPE-SPECIMEN. By S. M. TRACY, Director Mississippi Agrl. Expt. Station, Agricultural College, Miss.

REMARKS ON THE NORTHERN SPECIES OF VITIS. By Prof. L. H. BAILEY, Cornell University, Ithaca, N. Y.

THE POINT OF DIVERGENCE OF MONOCOTYLEDONS AND DICOTYLEDONS. By Prof. C. E. BESSEY, University of Nebraska, Lincoln, Neb.

THE DEVELOPMENT OF THE CYSTOCARP OF GRIFFITHSIA BORNETIANA. By ARMA A. SMITH, West Camden, New York.

MORPHOLOGY OF THE CANNA FLOWER. By Prof. L. H. BAILEY, Cornell University, Ithaca, N. Y.

DISTRIBUTION OF PLANTS ON FRESH-WATER ISLANDS. (Illustrated by lantern pictures.) By Prof. CONWAY MACMILLAN, University of Minnesota, Minneapolis.

Section adjourned Thursday evening, August 27.

SECTION H.

ANTHROPOLOGY.

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ADDRESS

BY

VICE-PRESIDENT

ALICE C. FLETCHER,

CHAIRMAN OF SECTION H.

THE EMBLEMATIC USE OF THE TREE IN THE DAKOTAN GROUP.

THE tribes of the Dakotan or Siouan linguistic stock aggregate in number about 45,000 Indians. Grouped according to a close relationship of language, we find in the United States:

32,000 in the Dakota; 4,000 in the Omaha, Ponka, Quapa, Kanza and Osage; 800 in the Iowa, Otoe and Missouri; 2,200 in the Winnebago; and 3,000 in the Hidatsa, Mandan and Crow tribes. The remaining 3,000 are widely scattered, with the greater part living in the Provinces of Canada.

At the beginning of the seventeenth century, a number of tribes belonging to this stock dwelt on a strip of the Atlantic coast, now within the limits of North and South Carolina, extending as far west as the Alleghanies, and north to the Maryland line, and controlling the headwaters of the streams flowing westward. They were in constant warfare with their Algonquian and Iroquoian neighbors, and were exterminated as tribes within the historic period. The majority of the Siouan Indians were already beyond the Mississippi, where they were met by early explorers, and where they now dwell. We find the purport of their traditions to be that they were slowly driven from their eastern home by implacable enemies, and that once beyond the Mississippi, they spread to the northern tributaries of the Missouri, westward to the Rocky Mountains, and south to the Gulf of Mexico, where recent investigations have brought to light a remnant of the Biloxi.

Contact with Algonquian, Iroquoian, Muskhogean, Caddoan, and

Kioan stocks, during the period of progress over this vast tract of country, has left its traces in the Siouan rites and customs; but the uncertainty that still clouds the past history of this people, makes it difficult to determine when certain rites were adopted, or to gauge with accuracy the modifying influences of other stocks upon native usages and beliefs. From the scant records left by early travelers, with the fragmentary nature of the information still obtainable from the few scattered survivors of the eastern and southern tribes, a full reconstruction of their social and religious customs is impossible; but enough can be discerned to indicate that the eastern, southern and western tribes were all under the influence of cults which seem to have been fundamentally the same.

In this paper is offered a slight contribution to the early history of social and religious development, inasmuch as in tracing the emblematic use of the tree in the Siouan linguistic group, we follow a people from a comparatively primitive condition, living in isolated bands, independently of each other, to their organization within the tribal structure, compacted by the force of common religious beliefs.

That ideas are the ruling force and "the constructive center" of human society, is readily conceded as applicable to our own race. It is equally true of the Indian; but, in according this power to ideas, the modifying influence of environment is not to be overlooked. One cannot conceive of man apart from environment, his contact with it is the very condition of being. As Herbert Spencer has phrased it, life is "the continuous adjustment of inner relations to outer relations."

This "adjustment" of man to his environment is the work solely of ideas, and the process, as evinced in this group of Indians, goes to show that those ideas which have formed "the constructive center" of the tribe are religious ideas.

Indian religions seem to have been subject to the same laws that have governed the development and growth of religions on the eastern continent. There, we know the several systems to have been begun with the simple utterances of a seer, which, as they were passed from mouth to mouth, became more and more clouded with interpretations, gradually expanded in detail, and finally formulated into ceremonials with attendant explanatory and dramatic rites. As time rolled into centuries, these ceremonies, with their accessory priests, came to be regarded as of supernatural origin, endowed

with superhuman power, and authorized to exercise control over the affairs of the tribe or nation; but the one living germ within the ponderous incrustation of doctrine and ceremony, that had accumulated throughout the ages, was still the surviving, vitalizing thought of the seer.

Turning to America, to the group of Indians of our especial study, we find traces of a similar history; for, penetrating beneath the varied forms of their religious rites, we come upon a few fundamental conceptions or thoughts, the most dominant of which perhaps is the idea of the all-permeating presence of what we call life, and that this life is the same in kind, animating all natural forms and objects alike with man himself. Coördinate with this idea, which has received the name of animism, is that of the continuity of life, that whatever has once been endowed with it, must continue to be a recipient of it; in other words, whatever has once lived must continue to live.

There is no reason to think that at any time in the past, it was possible for the idea of animism, or for any other idea, to have fallen into the mind of every savage simultaneously, as a cloud-burst drenches the plain. Ideas have ever made their way as they do now, slowly, and by being communicated and talked over. The idea of animism is a very remarkable one. It has been so built into the mind of the race, that it is difficult to imagine a time when it was not; and yet there was such a time, a time when man stood dumbly wondering at the birds and beasts, assailed like himself by hunger, and finding food from the same supply; at the alternation of day and night; and at the destructive and vivifying effects of the storm. But these wondering observations were like so many disconnected fragments until some thoughtful mind caught the clue that led to the bold and clarifying thought, that all things were animated by a common life, and that man was not alone upon the earth with strange and alien creatures, but was surrounded by forms replete with life like his own, and therefore of his kindred.

This mysterious power or permeating life was called in the language of the Omaha and Ponka tribes, Wa-ka*n*-da. This word is now used to designate the Deity. The original meaning, while conveying the idea of the mysterious, something hidden or unseen, also implied the power to bring to pass. Wa-ka*n*-da-gi, an adverbial form of the word, is applied to the first putting forth of a new faculty, as when a child first walks or talks, but the word

wa-ka*n*-da-gi would not be used to express the resumption of faculties lost by sickness or accident.

Fourteen years ago, while sitting with me in his tent, a thoughtful old Dakota Indian, who had never come under missionary influence, spoke of his native religion, in which he was a firm believer. He explained the teaching of his fathers, and tried to make me understand that the mysterious power which animates all things, is always moving and filling the earth and sky. He said, "Every thing as it moves, now and then, here and there, makes stops. The bird, as it flies, stops at one place to rest in its flight, and at another to build its nest. A man when he goes forth stops when he wills, so the mysterious power has stopped. The sun, the moon, the four directions, the trees, the animals, all mark where it has stopped. The Indian thinks of all these places, . . . and sends his prayers to reach the mysterious power where it has stopped."

This Indian had evidently been taught that the power pervading all things was one in kind, and possessed of a quality similar to the will power of man. He said, "A man when he goes forth, stops when he wills; so the mysterious power has stopped."

The Indian conceives of Wa-ka*n*-da as endowed with like, though greater powers than those possessed by man. The prayer chanted by every Omaha when he goes out to fast, seeking a vision:—

"Wa-ka*n*-da dhe-dhu wa-pa-dhi*n* a-ta*n*-he,"
Wa-ka*n*-da here needy I stand,

is an appeal to something that is believed to be capable of understanding the needs of a man, and implies a conception of Wa-ka*n*-da that is anthropomorphic. But the Indian does not apparently think of Wa-ka*n*-da as apart from, or outside of nature, but rather as permeating it, and thus it is that to him all things become anthropomorphized.

In a Ponka ritual the following address is made to the tree, as represented in the framework of the lodge in which the ceremony takes place:

"Oh! Thou Pole of the Tent, Ethka;
"Along the banks of the streams, Ethka;
"With head drooping over, there Thou sittest, Ethka;
"Thy topmost branches, Ethka;
"Dipping again and again, in very truth, the water, Ethka;
"Thou Pole of the Tent, Ethka; (The Tree now speaks,)
"One of these little ones, Ethka; (That is, the suppliant,)

"I shall set upon one (of my branches), Ethka;
"The impurities, Ethka
"All I shall wash away, Ethka."

The tree is supposed to take the man on its branches, as in one's arms, and dip him in the stream, where "all within the body" is "cleansed."

Long life is desired, and the Rock is invoked:

"Oh! Aged One! Ethka;
"Thou sittest as though longing for something, Ethka;
"Thou sittest like one with wrinkled loins, Ethka;
"Thou sittest like one with furrowed brow, Ethka;
"Thou sittest like one with flabby arms, Ethka." (The Rock now speaks.)
"The little ones (the people) shall be as I am, whosoever shall pray to me properly" (*i. e.* ceremonially).

Many other illustrations could be given to show the Siouan Indian's anthropomorphic conception of nature.

With the acceptance of the idea that all things were quickened with the same life, came the belief that a mysterious relationship existed between man and his surroundings, and it naturally followed that, in his struggle for food and safety, he should seek to supplement his own strength by appealing to his kindred throughout nature; should "send his prayers to reach the mysterious power where it has stopped." Said a venerable Indian to me one day, "The tree is like a human being, for it has life and grows, so we pray to it and put our offerings on it, that the mysterious power may help us."

Coördinated with these ideas concerning nature, was that of the continuity of life, which could not but lead to a belief in dual worlds with interchanging relations: thus, we find that these Indians were firmly convinced that the dead camp in the unseen world, as they did while upon earth, each gens having the same relative place in the tribal circle, and each person at death going to his own gens.

Among the Ponkas the Ta-ha-u-to*n*-a-zhi division of the Ni-ka-pa-shna gens, whose totem is the deer, put deer-skin moccasins upon their dead, that they may be recognized by their kindred, and not lose their way in the other world. Among the Otoes, when an Indian dies, his face is painted in a manner peculiar to his gens, by one having the hereditary right to perform this act, who says to the dead: "In life you were with those you have now left behind.

Go forward! Do not look back? You have met death. Those you have left will come to you."

The ancient chiefs, who "first took upon themselves the authority to govern the people," are still active, and through the rituals chanted at the installation of tribal officials, as through a medium, they continue to exercise their functions and to confer authority on their successors. The rituals call upon the animals which had supernaturally appeared to the first rulers, "The Crow, with frayed neck feathers; The Wolf, with tail blown to one side;" and they appeal to both chiefs and animals to remember their promise, and to continue to guide the people into safety and plenty through their successors now being ordained.

The Legend of the Sacred Pole of the Omahas, handed down from generations, gives a rapid history of the people from the time when "they opened their eyes and beheld the day," to the completed organization of the tribe, and the institution of the rites of the Sacred Pole. From it we learn, that changes in the daily life and material progress of the people did not come about through miraculous intervention, but through the mind of their wise men; and that every step in the path of progress was the result of "thought." "And the people thought," is the constant prelude to every betterment or invention. By "thought" they learned how to make fire, to build lodges, to weave, and finally to institute religious rites and ceremonies.

To quote from this Legend: "The people felt themselves weak and poor. Then the old men gathered together and said; Let us make our children cry to Wa-ka*n*-da. . . . So all the parents took their children, covered their faces with soft clay, and sent them forth to lonely places . . . The old men said You shall go forth to cry to Wa-ka*n*-da. . . . When on the hills, you shall not ask for any particular thing, . . . whatever is good, that may Waka*n*-da give. . . . Four days and nights upon the hills, the youth shall pray, crying, and when he stops, shall wipe his tears with the palms of his hands, lift his wet hands to heaven, then lay them on the earth. . . . This was the people's first appeal to Wa-ka*n*-da. Since that time, twice in the year, . . . in the spring . . . and when the grass is yellow, . . . this prayer is said."

A study of this practice, as still found among the tribes, shows that the youth, who uttered his prayer during days and nights of fasting, was not only asking help from Wa-ka*n*-da, but was seek-

ing a manifestation, in a vision, of that mysterious power. The form of this manifestation which should come to him, he believed to be that to which he must appeal when in need of help. The symbol of this form, which the youth ever after carried with him, did not in itself possess the ability to help, but served as a credential, by which the youth reminded the manifestation, be it of bird or beast, of the promise believed to have been received from it in the vision.

The dream and the vision were not the same, the dream of sleep came unsought in a natural way, while the manner in which the vision was striven for, indicates an attempt to set aside and override natural conditions. The natural dream has exercised an influence in many ways, but it has not had the constructive force of the vision.

The cry to Wa-ka*n*-da was the outcome of "thought" during the long barren period of primitive life. Whither this "thought" had tended we have seen in its culmination in the ideas that all things were animated by the same continuous life, and were related to each other. These generalizing ideas were not strictly in accord with the evidence of man's senses. The Indian could not help seeing the unmistakable difference between himself and all other objects. Nor could he help knowing that it was impossible for him to hold communication, as between man and man, with the animals, the Thunder, etc. The ancient thinkers and leaders met this difficulty by the rite of the vision, with its peculiar preparation. The youth was directed to strip off all decoration, to wear the scantiest of clothing, to deny his social instincts, and to go alone upon the hills, or into the depths of the forests; he was to weep as he chanted his prayer, and await the failing of his bodily strength, and the coming of the vision. In this vision he saw familiar things under such new conditions, that communication with them was possible; and his belief in the reality of his vision could not but reconcile the animistic idea with the normal evidence of the senses.

The psychological conditions favorable to a belief in the visions, and the ethical influence of the rite of fasting, in its results upon the individual and upon society, cannot be considered here, but the constructive power exercised by the religious societies, which had their rise in the vision, claims a moment's attention, as pertinent to our subject.

From the Legend already quoted, as well as from customs still

existing in these tribes, we learn that men who had had similar visions became affiliated into groups or societies, and acknowledged a sort of kinship, on the basis of like visions. For instance, those who had seen the Bear, or the Elk, formed the Bear or the Elk society, and those to whom had appeared the Water Creatures, or the Thunder Beings, were gathered into similarly defined groups. Within these societies grew up an orderly arrangement or classification of the membership, the institution of initiatory rites, a prescribed ritual, and the appointment of officers.

An important stage in the secular organization of the people was reached when the acceptance of Leaders—"men who took upon themselves the authority to govern and to preserve order"—came to pass. It would seem, from the evidence of traditions and rituals, that the establishment of these Leaders, which implied the segregation of the people into groups of followers, was of slow growth, and attended with rivalries and warfare. During this formative period, the early Leaders appear to have used the popular belief in the supernatural to strengthen their authority, so that they came to be regarded as specially endowed, and the efficacy of their vision was thought to extend over all their followers. In this way the symbol of the Leader's vision grew to be recognized as sacred to his kindred, and was finally adopted as the sign or totem of a common kinship or clan. This being accomplished, the taboo was instituted as a simple and effectual reminder of the totem of the Leader, and of the mutual obligations and relations of the members of the clan, which were further emphasized by the adoption of a set of names for each clan, all of which referred to its totem. Among the Omahas and Ponkas these names are called ni-ki-a, that is, spoken by a chief. In the ni-ki-a name, and the ceremonies attending its bestowal, there is a twofold recognition, that of a natural ancestor, and that of the supernatural manifestation of this ancestor's vision. We have already seen a similar acknowledgment of a dual source of authority, where, in the rituals, the chiefs, and the animals of their visions, are both invoked.

In the clan organization, the totem came to be representative preëminently of kinship; and its sign, as we have noted, was placed upon the dead, that they might be recognized by their kindred in the other world, and led directly to their clan. The function of the totem was social, rather than individual; the Indian depended for his personal supernatural help upon his own special vision, and

his clan totem in no way interfered with his entrance into any religious society.

The resemblance which exists between the rites and rituals of the religious societies, and those which hedge about the office of Chief, and Soldier, and Herald, marks the influence the societies have exercised upon the development of the tribal structure.

The control of the Thunder people runs like a thread through all the tribes of the Siouan group. The character of their vision was such as easily to win popular recognition as preëminently authoritative, and they seem to have been singularly dominant from the earliest time.[1]

The Thunder gentes had charge of, or took an important part in, all ceremonies which pertained to the preservation of tribal autonomy. To them belonged the rituals and the ceremonies which inducted the child into its rights within the gens and the tribe; the adoption of captives and strangers; and the ceremonial preparation of the tribal pipes, without which there could be no tribal ceremony or enforcement of order. They had charge also of the rites for the preservation of crops from the devastation of insects and marauders. These were some of the exclusive functions of the Thunder gentes; but the rites of the worship of Thunder itself, and the ceremonies pertaining to war, of which Thunder was the god, so to speak, were in charge of other than the Thunder gentes.

In the Omaha tribe the Sacred Tent of War was set apart for the rites and ceremonies connected with Thunder. It was pitched in front of the segment of the tribal circle occupied by the We-jin-shte gens, its Keeper. It stood apart as a special lodge, and was regarded with awe by the people. In it were kept the Sacred Shell (a large *Unio alatus*); the Wa-*in* (a bird-shaped bundle made of raw hide, containing the skins of certain birds believed to be associated with Thunder); the Pipes used in the ceremonies of war; and a Pole of cedar.

In the myths, the cedar tree is spoken of as the particular abode of the Thunder Birds. The Thunder Beings had their village amid a forest of cedars, and the club of these mythical beings was of

[1] The members of the Thunder society claim that, at death, they join the Thunder Beings, although they do not thereby lose their kinship rights in their clan in the other world, but an Indian born into a Thunder gens, could not at his death join the Thunder Beings, unless they had appeared to him in his vision. The people believed that the voices of noted Thunder men who were dead could be heard in the mutterings of the approaching storm.

the same tree. Cedar leaves were put upon the War Pipe after it was filled, so that when it was lighted, it was the aromatic smoke of the cedar that was offered to the Four Directions, the Zenith, and the Nadir. The cedar Pole, representative of Thunder, was called Wa-ghdhe ghe, which means the power to confer honors This name refers to the custom which prescribed that all war parties should start from this Sacred Tent and on their return report to it; and that all honors, namely, the right to wear certain regalia indicative of a man's prowess in battle, should be ceremonially conferred in this Tent.[1]

The vital point, in the ceremony of conferring honors, was when the warrior, standing before the Wa-*in*, and reciting his deeds of battle, at a sign from the Keeper, dropped a small stick upon the bundle. If the stick rested thereon, it was believed to be held by the Birds, who thus attested to the truth of the warrior's claims. If it rolled off upon the ground, it was the Birds who discarded it, because the man had spoken falsely. These Birds, representatives of Thunder, were the judges of a man's truthfulness, and rewarded him by honors, or punished him by disaster, even to the tearing out of his tongue by a lightning stroke.

Naturally in course of time, those warrior chiefs who by favor of Thunder had been successful in war, whose truthfulness had been attested by the Thunder Birds, and who had received their regalia, began to assume for themselves some of the authority, conceded by all to Thunder itself. A song belonging to a Dakota chief says, "When I speak, it is Thunder." Gradually the exercise of the punishing power was extended to social offences; as, for instance, a man whose persistent evil conduct threatened the internal peace of the gens or tribe, might suffer loss of property or even of life, his fate being determined by the warrior chiefs assembled at the Sacred Tent around the cedar Pole, the representative of the Thunder: the function of the chiefs thus becoming augmented by affiliation with the supernatural.

When the first Thunder was heard in the spring, the ceremonial of the worship of Thunder took place at the Sacred Tent. The

[1] All these regalia, which are graded in rank, refer to Thunder. In several of the tribes these are feathers of certain birds, worn in a particular manner; the peculiar painting of a man's face, body, or weapons; and, as among the Osages, the tattooing of the body and arms with lines so drawn that, when the highest rank is attained, the tattooed figure will represent the Thunder bird in outline.

Wa-*in* was opened and the bird skins exposed; the Pipes were smoked, the ritual sung, and the cedar Pole anointed. No one participated in these rites, except the members of those gentes whose totems were believed to be related to Thunder. Some of these totems were of creatures predatory in their habits, and therefore allied to the destructive lightning; others, like the eagle and the hawk, could soar to the very clouds, while the flying swallows heralded the approaching storm. This fancied kinship of their totems was the basis of recognition of a sort of relationship between the gentes themselves, which became the ground upon which these people united in the performance of ceremonies directed toward a common object of worship.

Although important steps had been gained in social development, none of the rites and ceremonies of the Sacred Tent of War tended to bind all the gentes together, but the Omaha ceremony of the He-di-wa-chi seems to have been adapted to meet this requirement. It is impossible to state as a fact that the He-di-wa-chi grew out of the experience of the people during the centuries when they were being slowly driven by wars, farther and farther from their eastern home; but, according to traditions preserved in the different tribes, it was during this period that group after group parted company, and the enfeebled bands became a tempting prey to active enemies. Nor was the danger always from without; disintegration sometimes resulted from the rivalry of ambitious Leaders, and, to quote from the tradition, "the wise men thought how they might devise some plan, by which all might live and move together and there be no danger of quarrels."

Many points in its ceremonial indicate that at the time of the institution of the He-di-wa-chi, the people had entered upon agricultural pursuits, and were not wholly dominated by those ideas which had been the controlling power when hunting and war were the principal avocations. The He-di-wa-chi took place in the summer solstice, or, according to Indian designation, at "the time when all the creatures were awake and out." The choice of the tree from which the Pole, the central object in this ceremony, was to be cut, is significant. It was either the cottonwood or the willow, both remarkably tenacious of life, sending forth shoots even when cut down and hacked into posts. In the Indian's words describing the time when this ceremony was to take place, we catch a glimpse of a shadowy idea of peace, for when dan-

ger stalked abroad the animals which were "awake" would not be "out" but in hiding; and in the choice of the tree with its abounding life, we note the beginning of an apprehension of the idea of the conservation of life. This helps us to open out and understand the terse and poetic expression of the Indian tradition concerning this ceremony, that "it grew up with the corn." The ideas embodied in this festival found their birth and growth in the cultivation of the maize, which held the people to their fields, preventing their constant wandering after the wild animals, and so inaugurating village life, and developing an appreciation of tribal unity.

The first act in the preparation of this ceremony was the cutting, by the Leader having it in charge, of seven cottonwood or willow sticks which were stripped of leaves with the exception of a small spray at the end thus making a miniature pole. These were sent to the chiefs of the seven original gentes who in their turn sent out the men of their gentes to cut similar sticks which were to be painted red and carried in the great tribal dance about the Pole.

While this was being done, the Leader selected runners to represent warriors, who were to go out as a scouting party would go in search of an enemy, and when they found the tree which was to be cut for the Pole, they were to charge upon it and strike it as they would strike a foe. In this ceremony of selection where war is so simulated, the recognition of the power and authority of Thunder is manifest, for no man could become a warrior except through his consecration to Thunder, the god of war. Moreover, it was believed that no man could fall in battle through human agency alone; he fell because Thunder had designated him to fall. So the tree, which had been struck as a foe, fell because Thunder had selected it. The tree thus chosen was now approached by the Leader who said, "I have come for you that you may see the people, who are beautiful to behold." Then with elaborate ceremonies, in which the Four Directions were recognized, the tree was cut down; the bark and branches, all but a tuft at the top, were removed and buried at the foot of the stump, and the Pole, with much ceremony, was carried to the camp, where it was painted by the Leader in alternate bands of red and black, symbolic of Life and of Thunder. When this was done the Leader said, "It is finished, raise him up that your Grandfather (*i. e.*, Thunder) may

see him."[1] The Pole then, being placed in position in a hole prepared for it, stood before the people as approved by the ancient Thunder Beings. Then the Herald went forth to call the people to make ready to welcome the Pole with dancing and gifts.

Now the camp is astir with preparation; every one dons his gala dress and hastens to take his place with his gens in the tribal order, forming an immense circle around the Pole. The singers, seated at the foot of the Pole, strike up the first of the ritual songs; at its close the war cry is given by all the people, who then advance a short distance and halt. Four times the song is sung, four times the cry is given, four times the people advance and halt, and at the last pause they are near the Pole. At this point the men of the In-ke-tha-ba gens, led by two pipe bearers, face about to the west, their right side to the Pole, and the women face to the east, with their left to the Pole. Each of the other gentes falls into like order behind the In-ke-tha ba men and women, and when the second ritual song is begun, the entire double circle begins to dance around the Pole. During the dance four halts are made, and at these halts if any dancer has passed beyond the line of his gens, he must return to it. The songs become more and more rapid in measure, and the dance fuller of mirth and gaiety. At the close of the ceremony the men, women and children throw their sticks at the foot of the Pole, to which they are tied and left for the sun and wind to dispose of.

The manner in which the Pole was approached by the whole people in the order of the tribal circle, with war cry and charge, was a recognition of the victories gained through the war-god Thunder. The entire ceremony was a dramatic teaching to old and young of the necessity of union not only for defence, but for the preservation of internal peace and order, in the security of which, industry might thrive and prosperity be within the reach of all.

The He-di-wa-chi, all the details of which cannot here be described, is a festival of joy; the words of the opening song are, "Come and rejoice!" The whole scene vibrates with color and motion; there is no hint of sacrifice, the Thunder selected tree is a symbol of Life, held in the fruitful grasp of the earth, and touched by the beneficent rays of the sun.

[1] These words, in the original, are of the nature of an invocation and consecration.

The so-called Sun-Dance of the Dakotas and Ponkas seems to have sprung from the same parent stem that bore the He-di-wa-chi; but it shows marks of the influence of tribal environment during the past few centuries, as well as traces of contact with other stocks. For a considerable period prior to our first knowledge of the Dakotas, these tribes had dwelt in the most northern range of the Siouan linguistic stock, and had almost lost their knowledge of the cultivation of corn. Omaha traditions say, that their own tribe turned back from the region where the Dakotas were when first discovered by us, because corn would not grow well there, and they sought sites for their villages farther south where they could raise the maize in large and unfailing crops.

The Sun-Dance and the He-di-wa-chi have fundamental features in common. They take place at the same time of the year; both Poles are cut from the cottonwood or the willow tree; the ceremonies attending the cutting and planting and decorating the Poles are practically the same, differing only in the elaboration of detail. Both are consecrated by and to Thunder, and about both, the tribe must gather in the order of the gentes. The special rites of the Sun-Dance are performed within a communal tabernacle erected about the Pole. It is made of one or more poles gathered from the tent of each family in the tribe, and covered with green branches. It represents the living branches of the tree, as well as the great congregation of the people, whose tents enclose it in a circle often more than a mile in circumference.

The elaborate character of this ceremony precludes the mention of any of its parts, except those which pertain to the subject of this paper.

The symbol placed upon the buffalo skull, and drawn upon the U-ma-ni—a space of ground from which the sod had been removed, and the earth made fine—is a circle with four projecting points equidistant from each other. This symbol, to quote from Dakota Indians who had been instructed in this ceremony, "represents the tribe and the Four Directions. It means that, wherever the tribe may travel, it will be kept whole. Its circle of tents will not be broken, the members of the tribe shall live long and increase. The symbol also stands for the earth, and the unseen winds that come from the Four Directions, and cross over the earth and bring health and strength." The people were told, that, "as long as they observed the ceremony, they would increase

and grow strong, but if they should neglect the rite, they would decrease in numbers, lose their strength, and be overpowered by their enemies."

The dramatic character of the adjuncts of self sacrifice and torture has diverted the attention of observers from the true purpose of the Sun-Dance, which has been clouded in the minds of the people themselves, but has not been lost sight of by the Indian priests, who still insist that the ceremony is necessary to the preservation of the people as a tribe.

The torture practised at the Pole seems to be a transference to this ceremony of the ancient rite known as Hanm-de-pi, where the man suspends himself, while seeking a vision through fasting; or when, fixing his mind upon a particular desire, he expects through torture to render its accomplishment certain. Even in the Hanm-de-pi, there are indications of foreign influence which tended not only to keep alive, but to intensify the more primitive forms connected with Thunder worship,—forms which had almost died out in the more southern tribes, surviving only in certain modified rites observed in mourning for the dead, and the leading of a war party.

In the absence of agricultural avocations and their attendant corn ceremonies, the belief that the Pole was selected and consecrated by Thunder came to be more and more pronounced, as is indicated by the fact that the Thunder men only could take charge of the Sun-Dance, whereas, in the He-di-wa-chi it was the red corn people who were the Keepers of the ritual and Leaders of the ceremony. It is easy to see how, through the influence of Thunder, originally represented in the consecration of the Pole and augmented by the dominance of the Thunder men, the torture rites came to be grafted upon a ceremony, which, owing to environment, had lost something of its early significance.

When witnessing the Sun-Dance, its composite character was impressed upon me, and the lack of unity between the parts was evident. Further study has shown how different rites have been united, and what are some of the influences which have brought about this grouping.

The Dah-pi-ke or Nah-pi-ke of the Hidatsas resembles the Sun-Dance. It takes place at the same season of the year. The Cottonwood Pole is selected and cut with similar ceremonies; about it the communal tabernacle of willow boughs is erected,

and all the people must gather to the rites. Like the Sun-Dance, it bears evidence of the same influences, which have overlaid a tribal ceremony "that grew up with the corn," with those other rites wherein self-torture was practised.

As in the He-di-wa-chi, the tree or Pole of the Sun-Dance, and of the Dah-pi-ke, is left at the close of the ceremony to the destruction of the elements, or powers, to which, in the mind of the people, it belonged.

In the Sacred Pole of the Omaha tribe, we have another offshoot from the same parent stem. In its rites, however, the fundamental ideas embodied in the ceremonies already considered, have been still further developed and specialized. The selection of the Pole, its cutting, decoration, etc., the season when its ceremonies took place, and the compulsory attendance of the people, were all practically the same as in the He-di-wa-chi, the Sun-Dance, and the Dah-pi-ke.

In a paper read before this Section last year, the Sacred Pole was described. Your attention at this time will be called only to its peculiar function in reference to the tribal autonomy.

A tradition in the tribe says: "At one time the seven original bands wandered about independent of each other; each band had a pipe and a leader. The Hun-ga gens thought, that if this continued there would be feuds between the bands. . . So the Sacred Pole was made, around which the different bands might gather. The seven chiefs were called together, and they all united and have been so ever since." The Legend corroborates the tradition, for it says; "The ceremonies of the Sacred Pole were devised to hold the people together."

The institution of the Sacred Pole marked a political change in the tribe, from the government by hereditary chieftains to an oligarchy of seven chiefs who attained their position by personal ability to perform certain deeds, called Wa-dhin-e-dhe. The name of the old cedar Pole of the Sacred Tent of War, Wa-ghdhe-ghe, which as we have seen meant "the power to bestow honors," was given to the new Sacred Pole, which became the fount of honors won in peace, for the Wa-dhin-e-dhe were not deeds of war; for their achievement, industry and accumulation of property, as well as valor were required. So also, whereas the honors, bestowed in the Sacred Tent of War, were worn by the warrior himself, or tattooed upon his own body, the ghdhe-ghe, or mark of honor

authorized by the power represented in the Sacred Pole, was placed upon the daughter of the successful aspirant, the woman being the industrial factor in the tribe. The mark of honor consisted of two symbols: upon the forehead of the girl was tattooed a small round spot representing the sun, and upon her chest and back, a circle with four equidistant points; the same symbol that was made upon the earth and the buffalo skull in the Sun-Dance, and bearing the same idea, of strength in unity.

The seven chiefs who formed the oligarchy must act as one man, for without unanimity in their councils nothing could be done. In their decisions all the seven men must be alike represented, and the resultant unity was believed to be derived from Wa-ka*n*-da, present in and acting through the mysterious Sacred Pole. To quote from the Legend: "The chiefs are slow to speak, . . . no word is without meaning, and every word is uttered in soberness, . . . believing the words come from Wa-ka*n*-da, so the words of a chief are few. They (the seven chiefs) have all one heart and one mouth . . . After a question is decided, the Herald proclaims it about the camp circle, . . . none of the people dare dispute it, for they say, It is the word of our Chiefs."

The two avocations upon which the life of the people depended were agriculture and hunting, and these were controlled by the ceremonies of the Sacred Pole. From the Pole was decided the time for planting the corn, and about it the ritual of the maize was sung. The great tribal hunt was under its immediate direction, the rules and regulations of which were an important part of its function. On this annual hunt, the people left their village and their fields in the care of a small guard and followed the herds, under the strict control of the Chiefs and of a body of men called Soldiers. During the entire time, two months or more, the rights and inclinations of the individual were held rigidly subordinate to the good of the tribe. The Sacred Pole was carried in advance of the people, as they moved from camp to camp. From its presence the runners went forth in search of the buffalo, and to it they reported upon their return. At the close of the hunt, the ceremony of thanksgiving and anointing the Pole took place, when the entire tribe gathered about this central object, erecting a communal tent for some of the particular ceremonies and offering gifts. Finally, the men enacted before it the events of their career, thus presenting a sort of dramatic current history of the tribe.

At the inauguration of the Pole and its ceremonies, to quote from the Legend: "The Leader said, this (the Pole) belongs to all the people, but it shall be in the keeping of one family." For over two centuries this Sacred Pole was preserved, and its tent was pitched a short distance in front of the segment of the tribal circle occupied by a subdivision of the Hu*n*-ga gens, its Keepers. It was regarded with fear and reverence, as the supernatural protector of the people, as the power that insured to them an abundant supply of food, and commanded the coördination of the gentes and the unification of the authority of the Chiefs.

In all these rapidly considered ceremonies, marking periods in social development of this group of tribes—development more or less modified by shifting environments—we note the constructive force of the religious ideas of the people: ideas which, represented by the word Wa-ka*n*-da and its kindred terms, imply the existence of an ever active, mysterious power, permeating all nature including mankind, with the same life, thus making all things related and anthropomorphic. We have seen how these generalizing ideas become concrete, through the medium of the vision, and capable of exercising a practical, formative influence. We have traced this practical, formative influence in the unifying power of the totem, which welds together an extended though partial kinship within the clan or gens. We have seen it also operative in the religious societies, where an indestructible bond holds the members together upon a basis other than that of blood relationship. The same influence has been found at work in the association of certain clans for a common worship, the tie of their association being a supposed relationship of their separate totems to Thunder, the object of their worship. We note also that the authority of Thunder was still further extended so as to embrace the entire tribe, inasmuch as every man was brought under its control through the rites and ceremonies connected with war. Furthermore, we discern that out of the ancient ceremonies connected with Thunder, wherein primarily the cedar tree was the mythical abode of the mystical Thunder Beings, and later, the cedar Pole stood as emblematic of their power and authority, were evolved the ceremonies that made use of the old symbols, but clothed them with ideas born of newer conditions.

In the He-di-wa-chi has been found preserved the outline of one of the simplest and probably oldest ceremonies instituted to draw the people together and unite them into an organized body. And

it is apparent that the Sun-Dance, the Dah-pi-ke, and the Omaha Sacred Pole, from the same root, kept the same fundamental aim in view, performing their ceremonies about the same central object, the tree or Pole, selected and consecrated by the all-powerful Thunder, recognized as the judge and rewarder of all the people. We have seen the Chiefs summoned to the He-di-wa-chi by a tree stick, sent from the Keeper of the ceremony, each Chief in turn sending forth the men of his gens to gather each man sticks for himself and family, and all the people assembled and dancing about the Pole by gentes, each one carrying his stick, which at the end of the ceremony was given back to the Pole. A simple object lesson: to teach that the tribe was, like the tree, animated by the supernatural mysterious power; and that the Chiefs were its strong limbs, upon which the smaller branches grew.

In the Sacred Pole ceremonies, the constructive idea was still further developed, until not only unity of gentes was required, but unity of authority among the Chiefs was enforced. This unity, whether as demanded in the enunciations of the chiefs, or, as necessary to the formation of the tribe, to the instituting of the religious societies, or to the development of the clan, depended upon the conception of Wa-ka*n*-da, as manifested in concrete form through the medium of the Vision. The ancient thinkers among the Siouan people, in the long centuries of an unknown past, came gradually to realize the helpfulness and power that lay in social unity. Out of this realization these ceremonies were slowly evolved, wherein the Pole, bearing the topmost branches of the living tree, stood in the midst of the assembled people, as an emblem of the presence and authority of Thunder, the universally accepted manifestation of Wa-ka*n*-da, and also, in its life and growth, as typical of tribal unity and strength.

PAPERS READ.

TUESDAY, AUGUST 25.

Topic of the day — ARCHÆOLOGY.

RESULT OF RECENT CAVE EXPLORATION IN THE EASTERN UNITED STATES. By HENRY C. MERCER, Doylestown, Pa.

SYMBOLIC ROCKS OF BYFIELD AND NEWBURY, MASS. By REV. HORACE C. HOVEY, Newburyport, Mass.

A CEREMONIAL FLINT IMPLEMENT AND ITS USE AMONG THE ANCIENT TRIBES OF TENNESSEE. By Gen. GATES P. THRUSTON, Nashville, Tenn.

AN ANALYSIS OF THE DECORATION UPON POTTERY FROM THE MISSISSIPPI VALLEY. By C. C. WILLOUGHBY, Peabody Museum, Cambridge, Mass.

SOME INDIAN ROCK AND BODY PAINTING IN SOUTHERN CALIFORNIA. By DAVID P. BARROWS, Claremont, Cal.

HUMAN RELICS FROM THE DRIFT OF OHIO. By Prof. E. W. CLAYPOLE, Akron, Ohio.

FRESH GEOLOGICAL EVIDENCE OF GLACIAL MAN AT TRENTON, NEW JERSEY. By Prof. G. FREDERICK WRIGHT, Oberlin, Ohio. (Published in the *American Naturalist.*)

RECENT EXPLORATIONS IN HONDURAS BY THE PEABODY MUSEUM. By Prof. F. W. PUTNAM, Peabody Museum, Cambridge, Mass. (Published in *Memoirs of the Peabody Museum.*)

BRIEF DESCRIPTION OF THE PREHISTORIC RUINS OF TZAC POKOMA, GUATEMALA. By Hon. JOHN RICE CHANDLER, Guatemala, C. A.

THE RUINS OF THE TEMPLE OF TEPOZTLAN. By MARSHALL H. SAVILLE, Amer. Mus. of Nat. Hist., New York City. (Published in *Bulletin of American Museum of Natural History.*)

THE PRESERVATION OF LOCAL ARCHÆOLOGICAL EVIDENCE. By HARLAN I. SMITH, Amer. Museum of Nat. Hist., New York City.

WEDNESDAY, AUGUST 26.

Topic of the day — ETHNOLOGY.

CLAN SYSTEM OF THE PUEBLOS. By F. W. HODGE.

THE PSYCHIC SOURCE OF MYTHS. By Dr. DANIEL G. BRINTON, University of Pennsylvania, Philadelphia, Pa.

ONONDAGO GAMES. By Rev. W. M. BEAUCHAMP, Baldwinsville, N. Y.

KOOTENAY INDIAN NAMES OF IMPLEMENTS AND INSTRUMENTS. BY Dr. A. F. CHAMBERLAIN, Clark University, Worcester, Mass.

MEANING OF THE NAME MANHATTAN. By WM. WALLACE TOOKER, Sag Harbor, N. Y.

KOOTENAY INDIAN PLACE NAMES. By Dr. A. F. CHAMBERLAIN, Clark University, Worcester, Mass.

INDIAN WAMPUM RECORDS. By Dr. HORATIO HALE, Clinton, Ontario.

SERI STONE ART. By Dr. W. J. MCGEE, Bureau of Ethnology, Washington, D. C.

THE BEGINNING OF ZOÖCULTURE. By Dr. W. J. MCGEE, Bureau of Ethnology, Washington, D. C.

CERTAIN SHAMANISTIC CEREMONIES AMONG THE OJIBWAYS. By HARLAN I. SMITH, Amer. Museum of Nat. Hist., New York City.

RECENT DISCOVERIES AND DISCUSSIONS AS TO PYGMY RACES. By R. G. HALIBURTON, care of Cunard Co., Boston, Mass.

MESCAL PLANT AND RITE. By JAMES MOONEY, Bureau of Ethnology, Washington, D. C.

FINLAND VAPOR BATHS. By H. W. SMITH.

RESOLUTION UPON THE APPOINTMENT OF A COMMITTEE TO REPORT ON "THE ETHNOGRAPHY OF THE WHITE RACE IN THE UNITED STATES." By Dr. DANIEL G. BRINTON, University of Pennsylvania.

THURSDAY, AUGUST 27.

Topics of the day — SOMATOLOGY AND PSYCHOLOGY.

ANTHROPOMETRY OF THE SHOSHONE INDIANS. By Dr. FRANZ BOAS, Amer. Museum of Nat. Hist., New York City.

PHYSICAL AND MENTAL MEASUREMENTS OF STUDENTS OF COLUMBIA UNIVERSITY. By Dr. J. MCKEEN CATTELL, Columbia University, New York City.

THE THEOLOGICAL DEVELOPMENT OF ONE CHILD. By FANNIE D. BERGEN, Cambridge, Mass.

NOTES ON CERTAIN BELIEFS CONCERNING WILL POWER AMONG THE SIOUAN TRIBES. By ALICE C. FLETCHER, Peabody Museum, Cambridge, Mass. (This paper was printed for private distribution by the author.)

THE PAPAGO TIME CONCEPT. By Dr. W. J. MCGEE, Bureau of Ethnology, Washington, D. C.

FRIDAY, AUGUST 28.

Topic of the day — GENERAL ANTHROPOLOGY.

CHARACTER AND FOOD. By Rev. GEORGE V. REICHEL, Brockport, N. Y.

ABORIGINAL OCCUPATION OF NEW YORK. By Rev. W. M. BEAUCHAMP, Baldwinsville, N. Y.

THE LIMITATIONS OF THE ANTHROPOLOGIC METHOD. By Dr. FRANZ BOAS, Amer. Museum of Nat. Hist., New York City.

NOTE. — The arrangement of titles in this Section is the same as given in the Preliminary Programme of the Section. Several papers were read out of the regular order, the authors not being present when the papers were first called.

The Section adjourned Friday evening, August 28.

RESOLUTIONS OF SECTION H.

At the first regular session of the Section the following resolution was offered by W. J. McGee on behalf of the Sectional Committee: —

"*Whereas*, This Section, the Association, the nation, and the scientific world have sustained an immeasurable loss in the death of John G. Bourke, scientist and soldier, and

"*Whereas*, The loss is peculiarly painful in the Section of Anthropology, to which he brought honor, long as a working member and later as Secretary; therefore,

"*Resolved*, that this Section here assembled join in an expression of grief for the death, and of reverence for the memory, of our associate and friend."

A memorial of Capt. Bourke by his friend and collaborator, Dr. Washington Matthews, was read by Dr. Brinton; and remarks of esteem and appreciation for the work and character of Capt. Bourke were made by Prof. Putnam, Prof. Perkins, and Miss Fletcher.

The resolution was adopted by a rising vote.

On Wednesday, August 26, by recommendation of the Sectional Committee, a Committee was appointed "For the purpose of advancing an acquaintance with the objects of Section H among both members and non-members." The members of this Committee are: J. McKeen Cattell, D. G. Brinton, and Franz Boas.

The following resolution was presented by D. G. Brinton: —

"*Whereas*, the influence which the environment of the New World has exerted upon the physical and mental development of the White Race is a question of the utmost scientific and practical importance, and

"*Whereas*, There appears to be no governmental or scientific bureau which is giving the subject attention at the present time, therefore,

"*Resolved*, That the American Association for the Advancement of Science appoint a Committee to organize an Ethnographical Investigation of the White Race in the United States, with special reference to the influence exerted upon it in its new surroundings, said Committee to report annually."

This resolution was adopted by the Section, and passed by the Council, and the following Committee was appointed: D. G. BRINTON, J. MCKEEN CATTELL, W. W. NEWELL, W. J. MCGEE, and FRANZ BOAS.

On Thursday, the following resolution was presented by Mr. MCGEE for the Sectional Committee: —

"*Whereas*, HORATIO HALE, long an active member and at one time a Vice-President of this Association, has made contributions to Ethnology and Philology entitling him to a place in the front ranks of American Anthropologists, and

"*Whereas*, It seems fitting that Mr. HALE's long and arduous labors in behalf of science should be recognized by the American Association for the Advancement of Science; therefore,

"*Resolved*, That Section H recommend to the Council that Mr. HALE be made a Life Fellow of this Association."

This was adopted by the Section, and passed by the Council, and Mr. HALE was made a Life Fellow.

SECTION I.

SOCIAL AND ECONOMIC SCIENCE.

OFFICERS OF SECTION I.

Vice-President and Chairman of the Section.

WILLIAM R. LAZENBY, Columbus, Ohio.

Secretary.

RICHARD T. COLBURN, Elizabeth, N. J.

Councillor.

WILLIAM H. HALE, Brooklyn, N. Y.

Sectional Committee.

WILLIAM R. LAZENBY, Columbus, Ohio, Vice-President.
R. T. COLBURN, Elizabeth, N. J., Secretary.
B. E. FERNOW, Washington, D. C., Vice-President, 1895.
WILLIAM R. LAZENBY, Columbus, Ohio, Secretary, 1895.
CHARLES E. WEST, Brooklyn, N. Y.
WILLIAM H. HALE, Brooklyn, N. Y.
JAMES A. SKILTON, Brooklyn, N. Y.

Member of Nominating Committee.

JAMES A. SKILTON, New York, N.Y.

Committee to Nominate Officers of the Section.

Vice-President and Secretary; and S. F. KNEELAND, Brooklyn, N. Y.; CHARLES P. HART, Wyoming, Ohio; ESTHER HERMAN, New York, N. Y.

Press Secretary.

R. T. COLBURN, Elizabeth, N. J.

ADDRESS

BY

VICE-PRESIDENT

WILLIAM R. LAZENBY,

CHAIRMAN OF SECTION I.

HORTICULTURE AND HEALTH.

I SHOULD be lacking in ordinary sensibility did I not appreciate the compliment of being elected Vice-President of Section I of the American Association for the Advancement of Science.

To be called to this office in an association that has for years stood for the scientific thought and scientific progress of this continent, — an association whose list of officers and members has contained the names of some of the most distinguished men and women of our time, — an association whose proceedings are an index of the marvellous advances made by scientific research during the latter half of the nineteenth century, — is truly an honor that any man or woman might covet.

Since accepting the honor, there are two words that have appealed to me with equal force and signal persistency.

These words are *responsibility* and *opportunity*. The former I have tried to discharge in an earnest effort to secure papers, and arrange an equally interesting and profitable program for this sectional meeting, and the latter I try to meet in the address which follows.

This year the title of Section I is changed, and its scope enlarged. It is no longer the Section of Economic Science and Statistics, but the Section of Social and Economic Science.

This change was precipitated by a series of resolutions presented before the Brooklyn meeting of 1894. The purport of the resolutions was, that inasmuch as the stated object no less

than the true function of the American Association is to promote the advancement of *all science*, including the science of society, it was in duty bound to aid and assist all desirable reforms, to the end that the progress of modern society, by the application of scientific principles and methods, might be advanced, and its perpetuity insured.

At the same meeting an amendment to the Constitution was proposed, which changed the name, as already stated, and so enlarged the field as to include all those branches of knowledge which deal with the political, commercial, economic, and social life of mankind. This amendment was adopted at the Springfield meeting of last year, and we now meet for the first time as a section of social and economic science. Permit me to add, that, in my judgment, the all-inclusive term "social science" would have been sufficient, for the word "economic" only defines a branch of the larger science already named.

We live in an era of reforms. At first, man was a reformer by primal necessity. He transformed or reformed nature to meet his bodily wants. His life was a mere struggle for existence.

In time he turned his eyes inward, and studied himself. He first dimly saw that there were higher ends and nobler purposes than mere sensual enjoyment. He slowly learned that his passions and appetites were created to serve and sustain, not to master and destroy.

Then turning his eyes outward, and scanning his relation to others, he found, not justice, much less love and good will, but necessity on the one hand, and advantage on the other, controlled the dealings of man with man. He met no recognition of the brotherhood of the human race. But progress is a law of our being, and we have now reached a point where ethical laws are being applied to practical life.

To this end are the various special reforms of this day and generation mainly directed. There are reforms in church and state polity, reforms in municipal government, educational reforms, prison reforms, dress reforms, reforms in eating and drinking, and numerous other special reform movements, which challenge our attention.

What the true, genuine reform spirit of our age is seeking to establish is the equality of human rights; an equality that disregards all disparities of race, sex, or color, of strength, knowl-

edge, or creed; an equality that is plainly and tersely expressed in the Declaration of Independence: —

"We hold these truths to be self-evident: that all men are created equal; that they are endowed by their Creator with certain unalienable rights; that among these are life, liberty, and the pursuit of happiness."

As a people we may be selfish, short-sighted, and sinful, yet there is a strong undercurrent of moral obligation to live for the highest good of humanity, to co-operate with that "power which makes for righteousness."

Through all the folly and evils of our time there comes to every discerning ear a voice which speaks to us in no uncertain tone. Its message is this: teach the child and you will not be obliged to hang the man; find the vagrant orphan a home, and teach him a useful trade, and you will not have to punish him as a thief, or watch him as a criminal; furnish work to all who need it, and there will be few to support as tramps, paupers, and parasites; remove temptation from the path of the weak, and you will not be obliged to punish them for having stumbled and fallen; it is better to counsel than to condemn, — better to lift up than to crush down, — better to be shielded by love and gratitude than to be protected by soldiers and police. Thus testifies the moral genius of our age. Let us try to understand and heed it.

The great, all-embracing reform of our age and country, one that naturally follows the banishment of human chattelhood from our soil, — one that is palpably demanded by every instinct of justice and humanity, — is that which will lift the industrial classes from the plane of servility to one of self-respect, self-guidance, and independence. Its object is to lift the laborer, not out of labor, but out of ignorance, inefficiency, and want. This great end cannot be attained at once, but the development of a truer and more profound social and economic science should help to pave the way.

The socialist has his dream of an ideal world. He believes it possible to have a social and industrial order, wherein all freely serve, and all are served in return; where no drones or sensualists can abide; where education is as free and common as air and sunshine, where nothing but service secures approbation, and nothing but merit wins esteem; where mental development and

moral culture is the aim, as well as possible attainment of all. Is such an order possible? What says social science?

It may be well to repeat here the question discussed by Vice-President Fernow at the last meeting of this Section.

Have we a social and economic science? Have we enough observations, facts, laws, principles, subservient to social and economic conditions, — so well arranged and classified as to warrant the use of the term *science?* I believe we have. Let me not be misunderstood. I am not a teacher of such science. I rank low in the class of learners. What I know of science as applicable to society and economics is slight indeed. Yet I know there is such a science, and I believe that each succeeding year enlarges, improves, and perfects it.

If some of the recent applications of this science appear shallow and seem almost to partake of the nature of quackery, this should not bar the way to our advance to the acquisition and development of a true social and economic science, which shall be neither shallow nor empirical.

In this spirit, and with no little hesitation, I present a few thoughts on "Horticulture and Health."

Ours is an eminently practical age. The energy of our people is mainly expended in the production, manufacture, and distribution of articles that nourish the body, gratify the senses, or in some way contribute to the comfort and convenience of mankind.

Mind is steadily dominating matter, and this extension of the sovereignty of man over the material forces of the earth we call civilization.

The art of horticulture consists primarily in transforming by means of cultivation, crude and worthless materials into substances valuable as food products, or useful in ministering to our love of the beautiful. This raw material is furnished by the soil, and such substances as may be added thereto, together with certain elements of the air.

Etymologically speaking, *horticulture* means the cultivation of a garden. The real scope of this definition depends upon the meaning of the word *garden.* According to philology, this word comes directly from the Anglo-Saxon *gyrdon,* to enclose. It is the root of the verb *to gird,* meaning to encircle.

Gardening and horticulture, like farming and agriculture, are synonymous terms. We should remember, however, that the full

scope of the meaning of a word is not determined by its derivation. This must be sought in its general use and common application. By this standard horticulture readily separates itself into four great divisions, each of which may be many times subdivided.

These principal divisions are: —

I. Pomology, or fruit culture.

II. Olericulture, or vegetable gardening.

III. Floriculture.

IV. Landscape-horticulture.

The first two of the above divisions belong to the realm of industrial or domestic art. The third, floriculture, is both an industrial and a fine art. While the last, landscape-horticulture, lies wholly within the province of fine art.

Horticulture is more than a mere trade. It is more than a productive industry. Its successful practice is based upon great laws which have been deduced from the natural and physical sciences.

Many of these laws may be arrested, modified, or set in motion at will.

The horticulturist, as he learns that the control of these laws is largely in his own hands, becomes an enthusiastic student and investigator, and can scarcely fail to develop a love for rural life, — a love that is deep and abiding. Horticulture may justly rank as a science, as well as an art. Not to speak of the science of the propagation of plants, or the science of tillage, the great fundamental principles of evolution are exemplified in horticulture as nowhere else. Over 6,000 species of plants are cultivated by the horticulturist, and these have produced almost an infinite number of distinct forms.

In these forms, with their wonderful and intricate variations, we can study the laws of genesis, and the master mind of Bailey and others are rapidly reducing the wealth of facts found in greenhouse, garden, and orchard to the semblance of an orderly, systematic, and progressive science. The influence of natural and artificial selection, the effect of soil, climate, and moisture upon development, the transmission of acquired characters, the formation of new species, are revealed in horticulture as in an open book. Here facts take the place of conjecture, and demonstration is substituted for theory.

In discussing the relation that horticulture bears to health, not physical health alone, but intellectual and spiritual health, have been considered. In like manner, the products of horticulture, as well as horticulture as a vocation or recreation, are taken into account. First, let us consider the effects of the use of our common garden and orchard products, as a part of an every-day diet.

There is a great deal of talk about health and diet that is equally foolish and hurtful; — foolish because it subserves no good end, and hurtful because it tends to fortify the pernicious idea that our bodies are in such wretched condition as to need constant tinkering, and that some sort of self-medication is a positive duty.

Like malaria, this affection is everywhere. How shall it be treated? In the place of this wide-spread delusion there should be an inbuilt conviction that there are certain articles known as foods, in the choice of which and in the quantity used each one has daily opportunity to exercise the virtues of common sense and moderation. But foods are not medicines.

A medicine is something which is taken into the body to produce a certain specific and unusual effect, the object being to counteract some injurious tendency or abnormal state. If taken when not needed, its effect is likely to be directly injurious. In order to maintain strength and vigor, and repair waste, the normally healthy body craves what is *wholesome*, not what is *medicinal*. When a thing has real medicinal value, it is almost certain to be unwholesome as a general article of diet. There is an old tradition, — even now quite generally believed, although gradually fading away, — that anything that affords us simple physical pleasure is dangerous, if not absolutely sinful.

So when one eats freely of fruits, he does not feel justified in simply saying he does so because he finds them agreeable, he likes and craves them, but is constrained to look wise and solemnly observe that " fruits are very healthy." Some even go so far as the German prince, and have for each bodily ailment a different variety of fruit. The prince said, " Whenever I meet with any misfortune or affliction, and am disposed to give way to my grief, I order a young goose nicely roasted, and eat as much thereof as I can: I always find that I rise from the table far less unhappy." Let us banish the idea of making a drug-

store of our fruit-gardens and orchards, and cease looking upon the family fruit-basket as a sort of homœopathic pill-box!

"Blessed are they that hunger and thirst," can be said as truly of our bodily wants as of our spiritual necessities: not blessed because they shall be medicated, but because "they shall be filled,"—filled with what tastes good, with what gives genuine and lasting pleasure.

In satisfying our hunger for fruit,—fruit that is well matured, juicy, and fine flavored,—we get perhaps the highest form of palate gratification with the least possible digestive effort.

Our ordinary fruits contain the following substances in greater or less proportions:—

1. A large percentage of *water*.
2. *Sugar*, in the form of grape and fruit sugar.
3. *Free organic acids*, varying slightly according to the kind of fruit. For example, the predominating acid is malic in the apple, tartaric in the grape, citric in the lemon.
4. *Protein or albuminoids*, substances containing nitrogen, which resemble the white of eggs, and are its equivalent in food value.
5. *Pectose*, the substance which gives firmness to fruit, and which upon boiling yields various fruit jellies.
6. *Cellulose or vegetable fibre*, the material that forms the cell walls, and which is found in all parts of plants.
7. A very small percentage of *ash* or *mineral salts*.

The substances named above are, with the exception of cellulose, essential constituents of a perfect diet. The percentages of the different nutrients are so small, however, that most of our fruit has little actual food value. For example, the nutrients contained in the strawberry, according to analyses made at the Ohio State University, are as follows:—

Carbohydrates	8.0 per cent.
Protein	.3 " "
Fat	.0 " "

It has been estimated that the minimum daily ration of nutrients for a man of average weight, performing an ordinary day's work, is:—

Carbohydrates	500 grams, or	17.6	ounces.
Protein	118 " "	4.2	"
Fat	36 " "	2.0	"

A simple calculation will show that a person would have to consume about 200 ounces, or 13 pounds, of strawberries daily in order to obtain the proper amount of carbohydrates from this source.

In order to secure the necessary amount of protein from the same source, a daily consumption of 1400 ounces, or 88 pounds, of strawberries would be required.

This would be a task that even the most ardent admirer of this fruit could scarcely be prevailed upon to attempt. Take another illustration from the vegetable, rather than the fruit garden.

The nutrients contained in the tomato are as follows: —

Carbohydrates	2.5 per cent.
Protein	.8 " "
Fat	.4 " "

Applying the same calculation as before will show that one would have to eat 500 ounces, or 31.2 pounds, of tomatoes each day for the requisite fat; he would have to eat 525 ounces, or 32.8 pounds, for the necessary protein, and for the carbohydrates it would require 704.4 ounces, or about 44 pounds. In other words, if one should eat 44 pounds of tomatoes every day, he would consume slightly more fat and protein than were absolutely necessary for a day's supply, and just about the right amount of carbohydrates.

This demonstrates that, however valuable strawberries and tomatoes may be as a part of an every-day diet, they cannot be considered as foods. Their actual nutrient value is exceedingly low. In order to support life and maintain strength, strawberries and tomatoes must be eaten in connection with other substances which have more concentrated nutrients. Wherein does their dietetic value consist? Let us briefly consider. The qualities which render fruit and many of the more delicate garden vegetables wholesome, and cause us to have a natural appetite for and hence to enjoy them, are their acid juiciness and flavor. The juice is mainly water, but it comes to us in a grateful and refreshing form. The flavor is due in part to the organic acids already mentioned, but mainly to certain volatile oils or aromatic ethers. It is to these latter that those delicate characteristic flavors of various varieties of fruit are chiefly due.

Chemistry and physiology have taught us that, when these "fruity acids," oils, and ethers are taken into the body, they

undergo oxidation, which process tends to lower the temperature of the blood, or at least to modify our temperature sensations, and thus correct, or allay, any slight feverishness that may exist. They also tend to keep the organs of secretion, the liver, kidneys, etc., in a healthy condition. We are justified, therefore, in saying that fruits are "cooling, aperient, and grateful." In our climate, subject as we are to rapid changes and extremes of temperature, passing abruptly, as we often do, from an arctic winter to a tropical summer, the physical system is naturally more or less debilitated.

In this condition we are predisposed to malarial troubles, particularly if we live where the drainage is poor. Fruits and acid vegetables are found to be good correctives for this debilitated condition of the system. The free acids of fruits, especially citric and malic acids, are highly antiseptic bodies. They tend to prevent disease germs from finding a lodgment and developing in the body.

The full beneficial effects of these acids are only to be found in mature fruits. Green, unripe fruits, although they have an abundant supply of acids, are usually injurious, on account of their indigestibility. This arises, mainly, from the coarse and hard condition of the cellulose. When fruits are perfectly developed and properly matured the cellulose is soft and fine. We know that unripe fruit is not wholesome. It digests slowly, often ferments in the stomach, and is the cause of painful disorders. It is unwise to take into our stomachs that which will ferment and decompose; it is certainly no less unwise to eat over-ripe or wilted fruit, in which these destructive changes have already begun. The question is often asked whether such or such a fruit is *healthy*, even when the question has no special reference to the condition of the fruit itself. All fruits that are eaten ought to be healthy. That is, they should be well matured, sound, and free from disease. As a rule, such "healthy fruits" are for most of us *wholesome*, although they are neither food nor medicine.

The best results possible from the dietetic use of fruits and vegetables come from eating those that are fresh, healthy, and properly matured, and which have been produced by our own skill and industry.

I am dwelling too long upon the relations of the products of horticulture to health.

Let us consider how horticulture as a vocation stands related to the physical, intellectual, and moral well-being of mankind. In order to maintain physical strength and vigor, at least four things are needful. These are pure air, nutritious food, unbroken sleep, and muscular exercise.

That vocation which comes the nearest to supplying these requisites of good health can scarcely be other than a desirable one. Judged by this standard, horticulture stands at the very head of the list. Its quiet, its segregation from strife and jealous rivalry, its unequalled opportunities for nature study, make it at once attractive and healthful. Blessed is he who works in greenhouse, garden, or orchard. As a rule, his day's exertion ends with the evening twilight, and he rises each morning with his physical energies renewed for fresh activity. To him is given that full measure of health only vouchsafed to those who spend most of their waking hours in the free, pure air, and renovating sunshine of the open country.

Health is not only wealth, but happiness, and the superior advantages of horticulture as a healthful vocation cannot be too strongly urged.

Floriculture and small fruit culture are pre-eminently adapted to women. There are few indusrtries where fairer returns for capital and labor expended are more certain: few that can be so well begun with small means, and still remain capable of indefinite extension. Fine fruits and flowers are in universal demand. They are the necessities of the rich and the appreciated luxuries of the poor.

Our densely populated commercial centres, our thronged and fashionable summer resorts, are rarely if ever adequately supplied with them. As a rule, they take all they can get, and then look around for more. You might double the largest annual yield of good berries, or fine roses or carnations, with profit to the producers. The home market for products of this sort is signally elastic, the demand ever keeping well abreast of the supply.

The same is true of winter forced vegetables. In the light of a personal experience of over twenty years, I can confidently affirm that the vocation of horticulture, when wisely and energetically followed, is a profitable one. I believe there are few pursuits which afford as bright prospects, or as full an assurance of reward for intelligent persistent effort, as does this.

Listen to a few facts. The vegetable forcing-houses belonging to the horticultural department of the Ohio State University have an aggregate glass area of a little less than 4,000 square feet. There are two plain structures which could be built at the present time for about $900 each. The total bench space in these two houses is a trifle more than one twentieth of an acre. During the past five years the annual sales from these forcing-houses have averaged about $600.

The following are among the more important crops commercially grown the past year, and the receipts of each: —

Lettuce	$406.10
Radishes	52.25
Beets	45.00
Cucumbers	48.50
Hyacinths	59.25
Total	611.10

When we consider that these forcing-houses are used but little more than one half of the year the result attained is encouraging. It should be stated that in addition to the above crops there were grown in less quantities, and chiefly for experimental purposes, parsley, peppers, egg-plant, cauliflower, string-beans, onions, and a few other vegetables, including mushrooms, as well as a somewhat smaller list of flowering plants.

The cultivation of the small fruits is likewise peculiarly suitable for women. It is a business for both old and young. Examples are not wanting to show signal successes attained in strawberry, currant, and gooseberry culture, by women as well as men, when begun in the decline of life.

Small fruit culture is an industry that especially commends itself to poor women who are struggling to support their children in frugal independence. Almost any one can obtain control of a cottage with a half-acre, more or less, of warm, southward-sloping land, which can be planted with early vegetables and small fruits, in such a way as to be a source of continuous profit. If a small forcing-house can be added, and to this can be accorded that constant supervision without which no industry is likely to prosper, it will be an added source of revenue. In this way many a widow could find a healthful, congenial occupation, which did not require her to spend her days away from home, or

subject her to the caprices of a selfish or thoughtless employer. I believe there is no other occupation in which, for the capital invested, success is so nearly certain as in horticulture. Of every one hundred men who embark in trade, carefully collected statistics report that at least ninety fail. Why? Mainly because competition is so sharp and traffic so enormously overdone. If one hundred men endeavor to support themselves and families by merchandise in a town which affords adequate business for only ten, it is absolutely certain that a large majority must fail, no matter how able their management or how economical their living. On the other hand, the number of horticulturists in almost any community might be doubled without necessarily dooming one to failure, or even abridging his income. If one half of the day laborers in the country were to embark in horticulture to-morrow, I do not believe it would render the industry one whit less profitable, while it could scarcely fail to add to the health, wealth, and comfort of all.

I shall have little to say regarding the relation of horticulture to intellectual health. Any true knowledge of the art or practice must be based upon science.

The horticulturist stands face to face with problems which require for their solution the amplest knowledge of nature's laws, the fullest command of science, and the best efforts of the human intellect. In this art study and mental acquisition, together with a habit of observation and reflection, are equally essential and serviceable. However it may be with others, the horticulturist imperatively needs a knowledge of the character and constitution of the soil he tills, and the plants he cultivates, and the laws which govern their relations to each other.

Geology, chemistry, and botany are the sciences which unlock for him the secrets of nature, and a knowledge of these is among the most vitally urgent of his needs.

Horticulture is an intellectual pursuit, and in its practice the strongest minds may find scope for profitable employment. The one who chooses this profession must keep his mind open and his mental faculties alert by constant observation and study. Horticulture is esteemed by all, because every useful vocation is respected in proportion to the measure of intellect it requires and rewards, and never can rise above this level.

The relation of horticulture to moral and spiritual health de-

serves a more extended consideration. The horticulturist deals directly with nature, and finds little or no temptation to juggle or stoop to trickery. "Whatsoever a man soweth, that shall he also reap," is immediately and palpably true in his case. Nature never has been and never can be cheated.

The horticulturist, acting as a horticulturist, soon comes to realize that his success depends upon absolute verity, and he is not likely to be lured from the straight path of integrity and righteousness. When he goes into the markets and becomes a trader he is subjected to the same temptations as others, and may be enticed into some of the many devious ways of rascality. The whole tendency of his vocation, however, conduces most directly to a reverence for honesty and truth. It is likewise conducive to a genuine independence and thorough manliness of character.

The horticulturist is not obliged to swallow any creed, support any party, or defer to any prejudice, in order to successfully follow his calling.

He may be a democrat, republican, populist, or prohibitionist; a gold-bug or a silverite; a free-trader or a protectionist; Christian or infidel; yet his fruit and flowers will sell for exactly what they are worth. Social intolerance of adverse opinions is never directed toward him.

But it is horticulture as a *fine art* that has the most abiding influence. Who can measure the effect of the landscape-horticulture of our parks and public grounds, or estimate the value of the external adornment of the home?

Horticulture is nature's best interpreter, and through this art the blinded eyes may be opened, the dormant æsthetic powers awakened, and the heart made ready for a just appreciation of the beautiful. It is well to bring art into our homes, to adorn and decorate them with painting and sculpture; but we must not forget that the sense of beauty must be cultivated before the treasures of art can be made our own. If I were called upon to point out one of the most serious weaknesses in our modern system of education, I should answer, "Its failure to accustom the eyes of childhood and youth to the beautiful in nature." The beginning of all true education should be a love of nature, and *nature-study* ought to be the dominant note in every educational system.

What a wealth of beauty there is in tree and shrub and

flower, — a beauty of which we never tire, and which "is its own excuse for being!" When the art of horticulture arranges trees and shrubs, flowers and lawn, so as to present an expressive picture to the eye, the beauty is multiplied, and this development of the beautiful is the end and aim of all landscape-horticulture.

The claims of horticulture in answering our spiritual needs are no less than they are in answering our physical necessities.

In the first and most essential of human arts we are beginning to recognize one of the last and most useful of human sciences.

How and *where* and *when* can this art and science best do its appointed work?

It is a part of my social creed that there need be, and should be, no paupers who are not infantile, imbecile, or disabled. Yet the world is full of men and women doing nothing, mainly because they don't know how to do anything. To correct this, youth should be a season of instruction in some trade or useful art, as well as in letters and various sciences. There should be a blending of labor with study, of training with teaching, so as to preserve health of body and vigorous activity of mind.

The pupil or student should be enabled to nearly or quite make his way through high school, academy, and college, and go forth qualified to face adversity and maintain a healthful independence. One step toward the accomplishment of this desired end would be the introduction into our country schools of manual training in horticulture. The land required could be easily secured, and the necessary equipment in the way of tools, seeds, etc. would not be expensive.

The work undertaken in these training schools should embrace the cultivation of fruits, vegetables, flowers, shrubs, and trees. In connection with the above the various operations of propagating plants by seeds, cuttings, budding, grafting, etc., should be thoroughly taught. The collection and planting of weeds, the breeding of the more common injurious insects, and the use of remedies, the study of bees and useful birds, a practical acquaintance with our native trees and shrubs, and other similar subjects, might form a part of the instruction and training.

The introduction of such a course would mean an improvement of our schoolhouse grounds, and the adornment of these would have an elevating effect upon the whole community.

If we have beautiful school buildings, with beautiful sur-

roundings, the inference is almost irresistible that we shall have teachers and pupils of greater refinement. To develop all the faculties of body and mind is the aim of modern education Manual training in horticulture can signally aid in securing this end.

I sincerely hope that the obvious advantages of forming horticultural colonies will be widely and rapidly improved. It would correct the unhealthy congestion of our towns and cities. In no other way can so many be provided with homes, regular employment, and good living. By a horticultural colony I mean the association of from one hundred to five hundred families, in the purchase of a suitably located tract of land, embracing about one acre for each individual. The location, which should be reasonably near some large commercial centre, and the purchase of this land should be intrusted to the most capable and honest members of the association. It should be carefully surveyed and divided into a few small lots, centrally located, for the necessary mechanics and merchants, but mainly into areas of from one to ten acres for horticulture. Ample reservations of the best sites should be made for a schoolhouse, town hall, and public park. The streets should be embowered with shade trees, and every owner of a lot or garden should be encouraged to beautify and adorn it.

I believe such a co-operative effort would secure a modest but comfortable home for any family that could contribute from $300 to $500. If the contribution ranged from $500 to $1,000, a proportionally better home could be secured. Some of the advantages of such colonization over the isolated system of taking up a homestead may be summarized as follows: —

First. — One tenth of the land required under the old system would be found abundant.

Second. — It could be far better selected with reference to markets, and more suitable allotments for fruits, garden vegetables, floriculture, nursery, etc. could be made.

Third. — Few draught animals and little expensive machinery would be required.

And, finally, man's social and gregarious instincts would be satisfied.

While ignorance and miseducation ruin thousands, I believe that poverty resulting from involuntary idleness sends more men and women to perdition than any other cause.

Horticulture may never become a universal panacea for destitution and crime, yet I have a joyful trust that thousands will be awakened by it to a larger and nobler conception of the true mission of labor, and by its practice, along the path of simple, honest, persistent work, life may be made easier, and men and women healthier and happier.

PAPERS READ.

Beginning Tuesday, August 25.

The monetary standard. By Dr. W. H. Hale, Brooklyn, N. Y. (Published in *Bachelor of Arts*.)

Competition of the sexes and its results. By Lawrence Irwell, Buffalo, N. Y.

Fashion, a study. By Prof. S. Edward Warren, Newton, Mass.

Citizenship, its privileges and duties. By Dr. Stillman F. Kneeland, Brooklyn, N. Y.

An inheritance for the waifs. By Dr. C. F. Taylor, Philadelphia, Pa.

The proposed sociological institution. By James A. Skilton, New York, N. Y. (Published in *Journal of Sociology*.)

What is true money? By Edward Atkinson, Boston, Mass.

The value of the social settlement. By Aaron B. Keeler, Buffalo, N. Y.

Human reciprocity.—The vanishing neighborship. By Mary J. Eastman, Washington, D. C.

Relics of ancient (legal) barbarism. By Dr. Stillman F. Kneeland, Brooklyn, N. Y.

The crime against labor. By Edward Atkinson, Boston, Mass.

Suicide legislation. By Wm. Lane O'Neill, LL. D., New York, N. Y.

Better distribution of weather forecasts. By J. H. Miller, Cairo, Ill.

The Section adjourned Wednesday, August 26.

EXECUTIVE PROCEEDINGS.

REPORT OF THE GENERAL SECRETARY.

General Session, Monday Morning, August 24.

The first General Session of the Forty-fifth Meeting of the American Association for the Advancement of Science was called to order at 10 A. M., Monday, August 24, 1896, in the Chapel of the High School Building, Buffalo, N. Y., by the retiring President, Edward W. Morley, who introduced President-elect Edward D. Cope in the following words: —

It is a little difficult to believe that, only two centuries ago, a man could master all of the exact and precise knowledge which had then been attained by the human race. But it is only two hundred years since Leibnitz lived; and it was said of Leibnitz that he drove all the sciences abreast. Science has now become much too varied and extensive for any similar mastery; we must be specialists, each familiar with some chosen fraction of science; and, for most of us, the fraction is a small one.

Some evils may come from this. I do not think they have become very sensible within our Association. Many of us can, at least, feel an intelligent and cordial sympathy with the aims of those sections which are the most remote from our own. Within a somewhat narrower range, we can also comprehend the problems and results of others; and within the smaller circle which touches our own, we can even understand methods, as well as results and objects.

But when a chemist has to introduce, as his successor in office, a student of paleontology, he can speak with no critical fulness of knowledge. His words must be few and general.

It is no small matter that our President-elect is well known to us as an accomplished editor and a skilful writer. But his principal work has been more important than this. He has adorned and enriched the sciences of Comparative Anatomy, of Osteology, and of Paleontology with many and important additions. I may allude to the new light which he has thrown on the origin of the vertebrate structure. It is the high and well established reputation which such labors have conferred on him which has commanded our suffrages for the office which he now accepts.

Professor Edward D. Cope, it gives me great pleasure to yield to you the chair of the President of this Association.

President Cope then took the chair, and called upon Bishop Charles H. Fowler, D. D., of the Methodist Episcopal Church, to pronounce the invocation.

After the invocation President COPE introduced His Honor, Mayor EDGAR B. JEWETT, CHAIRMAN OF THE LOCAL COMMITTEE, who welcomed the Association to Buffalo in these words: —

MR. CHAIRMAN AND MEMBERS OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE, —

In the name of the people of Buffalo I extend to you a sincere and hearty welcome.

We are mindful of the distinguished honor you have done us by choosing Buffalo for the fourth time as the place for holding the Convention, and hope that you will have no cause to regret your choice.

It is a pleasure to us to entertain in our humble way men who have dedicated their lives, as you have done, to the cause of science.

I hope this session will be full of profit to you all; that you will be enriched in knowledge by reason of having attended it.

I trust that the cause of your noble professions will not so completely absorb you as to make you indifferent to the many and varied charms of the city of Buffalo at this season of the year.

If you will look about during your stay with us, you will find that Buffalo is a large and busy city. Her citizens are quiet, thrifty, industrious, law-abiding, and liberty-loving. They are conservative in business affairs, but open-hearted and most hospitably inclined toward the strangers who are within our gates. It is a city of individual homes, and not of tenements. It is a city of comfort, and not of show, of sincerity, and not of sham; of neatness, cleanliness, sobriety, and health. Our doors are open wide to you, and we hope that you will see as much as possible of our city during your stay.

Should you desire to know the cause of the stability, contentment, and conservatism of our people, I would refer you to the resident districts with their miles and miles of individual homes, more of them than any other city in the country can boast.

Again I extend to you, most cordially, the freedom of the city, hoping you will be pleased with our humble efforts to entertain you, that you will carry away pleasant memories of your visit to Buffalo, and a desire to come again at some future time.

President COPE then introduced Dr. ROSWELL PARK, President of the Buffalo Society of Natural Sciences, who gave the following address of welcome: —

The members of the Buffalo Society of Natural Sciences have done me the great honor to make me their spokesman upon this occasion in extending to you their most cordial welcome to our fair city. How fair, how pleasant it is, you may better realize when I remind you that, with more than one third of a million of inhabitants, we had during the recent hot season only two deaths from heat prostration, while New York City had during the same time about seven hundred. But though we had the lowest mean temperature of any city in the country during the heated term, we nevertheless hope to show you that our welcome is not gauged by the thermometer, nor our hospitality regulated by isothermal lines. As citizens we are proud of our city, and it is not our smallest boast, by any means, that you meet here now for the fourth time. We would ask those who have been here before to compare our present with our past, and see with what

rapid strides we are becoming one of the largest and most prosperous cities of the continent.

It would surprise you if I told you all our commercial prosperity. Let it not provoke a smile when I say that more tonnage enters and leaves our harbor than any other harbor in the world, save Liverpool. In fact, it is nearly as large as that of the whole Atlantic coast.

With such commercial prosperity, you might naturally expect to find here great institutions of learning. Such, indeed, we have, but perhaps they are less conspicuous in a city where business interests dominate as they do with us.

Among our prominent educational influences we include, and modestly mention, first, our own Society. This was chartered in 1863, three years before your first meeting in this city. Our first President was Judge CLINTON, whose name stands high on the honor roll of New York State. You see while your Association was resting during the period of civil strife, from 1860 to 1866, and holding no meetings, our Society was born.

Not the least of our pleasant recollections in seeing you now is the remembrance that after the period of your inactivity was over, your first meeting was held in Buffalo, and that 79 men met here in 1866 and practically reorganized your Association. We have not forgotten that at that meeting Prof. BARNARD presided, that in 1876 Prof. ROGERS was in the chair, and that in 1886 Prof. MORSE was President. Nor are we likely soon to forget Prof. COPE, who now adorns the position. I know well that of the early Presidents Prof. JAMES HALL alone survives, — he of whom our State is also and justly proud. By a coincidence of no import whatever, and probably of interest only to myself, it happens that my father of the same name was, in 1848, one of the founders of your Association, his name appearing as such in the first volume of your Proceedings. You can imagine then that it gives his son a peculiar pleasure to extend to you this welcome.

Our own avowed object is the promotion and study of the natural sciences through the formation of a museum and library, the procurement of lecturers, etc. Working, as we must, with practically no endowment nor revenue, we are not ashamed of the size of the collection both of books and specimens, with which our somewhat ample rooms are well filled, — to which rooms we cordially invite you at all times, and particularly after the formal exercises of this evening, when they will be open for an informal reception to your officers and members by the citizens of Buffalo.

The specimens in our cases number some 27,000; our working library consists of 3,500 volumes. In our museum, the collections of which we are particularly proud are those of American Bison, nothing equal to it being in existence; our collection of local fossils; of eggs; Judge Clinton's large herbarium; the Wadsworth collection of minerals, valued at $30,000, which is unrivalled in some respects; and the Riggs collection of Mound Builders' pottery.

We really have been a large influence in our community. Last year our rooms were visited by some 30,000 people. The school children of the city and their teachers have always been particularly welcome. Our meetings are held regularly during the active seasons, and lectures have been given under our auspices by many eminent men; and so it happens that, though few scientific societies in the country have had more uphill work, we are yet proud of what we have accomplished with our means.

Buffalo is a great convention city. Its all around activity has brought here this summer all sorts and conditions of organizations. Even the politicians infest it. To this fact it is due that city aid has been denied us in doing all that we wished to do for your pleasure and entertainment. We have had to depend solely upon our good friends, who have not disappointed us, and we are able to beguile a number of your leisure hours. It is our particular hope that you may visit Niagara Falls with us at the conclusion of the meeting, in order that you may see what man has done in harnessing nature, and enjoy the river trip, which is not surpassed by any excursion of its kind in the world, either for study of nature's scenic effects or the marvels of man's ingenuity. The power works and the carborundum manufactory will there be open for your inspection, with perhaps other recent enterprises. But before you go there we want you to visit certain of our home institutions. Our water works are well worth a trip that you may see how the problem of supplying a large city with an abundance of pure water is beautifully and simply solved. The Buffalo Library building, in which is to be found our own home, contains a large public library, maintained without city aid and watched over by a talented librarian, Mr. LARNED, whom we always delight to honor. On the upper floor of the same building the Historical Society has its quarters, where you may find many interesting relics of the days when different races and nations contested bitterly for possession of what is now our frontier. Indeed, were this the place and time to go into local history much might be told you, only a portion of which has been related in story or sung in verse.

A little farther up town you will find the Grosvenor Library, a large reference library, housed in its new quarters, which are admirable of their kind. To the medical contingent of your Association, which has always afforded tempting company for medical men, the University of Buffalo, which has just celebrated its semi-centennial, offers a fine museum, a large library, and a peculiarly attractive building for its medical school, which you are also invited to inspect. When last you met here, by the way, our University was solely a medical school. Now it has five professional schools and 700 students, another evidence of our scientific growth. The Niagara University also maintains here a medical department, the two universities for the present completing and rounding out our list of technical educational institutions.

Aside from these matters, there are connected with our home society a number of smaller affiliated clubs, each devoted to some particular form of nature study. It will be their pleasure to render such attention to those of your members who are similarly interested as time and weather may permit in the way of excursions to some of the many points of interest in the neighborhood.

I am further authorized by special vote of its directors to extend to the registered members of the Association the hospitality of the Buffalo Club during the week of this meeting. Cards of invitation are in the hands of the Secretary, and will be issued to every one who registers.

It has been stated, and most justly, that associated action is the mainspring of progress and advancement, both in science and in commercial enterprise. No more conspicuous illustration of the truth of this assertion can be met with than this society can furnish. Recognized at home as the leading organization of the continent, and abroad as the peer of any foreign society, you have done in the

past, as you will continue to do in the future, most noble and conspicuous good. I can only conclude these heartfelt and inadequate remarks by wishing you as successful a meeting this year as you have had in the past, and in assuring you that Buffalo's citizens take pride in welcoming you here, and in extending you every hospitality. We particularly hope, too, that in 1906 we may have the great pleasure of greeting you here again.

In reply to the addresses of welcome, President COPE said: —

MR. MAYOR, LADIES AND GENTLEMEN OF THE LOCAL COMMITTEE, AND CITIZENS OF BUFFALO, —

I utter the sentiments of the American Association for the Advancement of Science in expressing our pleasure at being once again in your beautiful city. We feel at home here, as we know that we are among friends who understand our motives and our objects. But, inasmuch as we represent the entire nation, I will give a brief outline of the objects of the Association and the aims which it has in view. Our principal occupation is that of original scientific research, although many of us are of necessity teachers of scientific knowledge. The primary object of the Association is, however, not teaching only, but the advancement of science by the increase of knowledge. We seek to penetrate the unknown and to build up a system by which we may understand with certainty the mutual relations of the various parts of the universe, including ourselves. Although many facts are known and some laws have been discovered, more facts remain unknown and we have not yet ascertained many of the highest principles of nature. Original research furnishes the material for teaching and the matter which is contained in books. Much money is devoted in this country to the building of libraries and of schools, but not much is given for the purpose of supplying the knowledge which is to be taught in the schools and from which books are made.

The motives of the original investigator vary with his years, but the taste for research is generally developed early in life. In some it is a love of the beautiful, whether it be the beauty of a perfect mechanism or the beauty of form that attracts him. In some, it is the desire to know, and in others it is a high interest in the problem of human origin and destiny. In many it is the same feeling which prompts the adventurous explorer to enter a new region, not knowing what he will find, but believing that whatever is, is right.

The services rendered by science are twofold. They have a value either material in their character or utilitarian, or they have a mental value, inasmuch as knowledge serves to clear the mind of fears and doubts and so to promote human happiness. The true man of science is not influenced by utilitarian considerations, but he pursues the truth wherever it may lead, knowing by experience that its benefits are many and sometimes unexpected. Another benefit which the cultivation of science promotes is the formation of correct habits of thought. The rational faculty of mind is of very ancient origin, and developed early in the history of man. But its use in the early stages of human development has been largely *a priori*, that is, in advance of knowledge, rather than as a digester of knowledge after its acquisition. In other words, the scientific method consists not in the use of abstract reason, but in a reasonable use of the results of observation and experiment. This is the lesson which the

history of science teaches mankind, that, if we wish to know the actual state of affairs, our course is first to observe the facts, and then to draw our inference from them, and not to describe the universe from our inner consciousness as we think it ought to be. All the results attained by science have been due to adherence to this method. However, it is not forbidden to entertain hypotheses before discovery, if such hypotheses are not valued for more than they are worth. Another service which we imagine that science renders to the community is the example which it offers of the reward of labor. The scientific man loves to work, not only for the sake of acquisition, but also because of the pleasure there is in work as an activity of the human organism. By it we learn that by work only can great results be accomplished, and the law of conservation and correlation of energy teaches that something cannot be made out of nothing.

In our educational function we hope by example to show that the mental life is as worth living and affords as much pleasure as the physical life. This is a lesson on which it is necessary to continually insist, and since mankind is constantly prone to imagine that mental activity and thought are uninteresting or painful, in spite of the fact that they afford pleasure of a high class and one conservative of the entire organism.

Second. We wish to emphasize the desirability of free thought on all subjects whatsoever, with the necessary condition that thought shall be careful and judicial. Thought so applied to our practical affairs must be in the highest degree beneficial in every direction, both personal and national. We expressly repudiate two common types of thought. One of these attempts to prove by reasoning, if not by reason, a contention in which a person has especial interest. It is to be feared that this habit of mind is too common, and it implies a lack of honesty of purpose which is entirely foreign to the scientific spirit. The other type of thinking to which we object is the acceptance of allegations concerning matters of fact and theory, upon insufficient evidence, or upon authority only. Both of these methods lead to inaccurate results, and from both the scientific method protects us. I do not hesitate to say that the future of science will be greater than its past, and that it affords a career to those who are adapted for it, which promises a high degree of happiness and benefit. I believe that in this country, with our facilities in various directions, the pursuit of science will become a more conspicuous part of our national life than it is now, and I am sure that nothing is more desirable for our national life than that this should be the case. In the cultivation of science we see the cultivation of honesty, of industry, and of truth, all qualities which are essential to the prosperity of a people.

Fellow citizens of Buffalo, we thank you for the very material aid which you are rendering us in the attempt to develop this enterprise.

The Permanent Secretary read the list of members deceased since the last meeting. This list is printed in full in another part of the volume, and includes the names of deceased members which have not previously been entered on the printed lists.

During the past year the Association has lost three of its founders and one of its past Presidents.

The following announcements were made by the GENERAL SECRETARY. —

1. A vacancy exists in the Vice-Presidency for Section A, by reason of the absence of Prof. WM. E. STORY, owing to the sickness of his wife. Nomination to this position will be made by the COUNCIL at the General Session on Tuesday. As Vice-President Story's address is not prepared, the announcement for the afternoon should be cancelled.

2. Prof. A. C. GILL, Secretary of Section E, has resigned on account of his journey to Greenland.

3. The death of Capt. JOHN G. BOURKE, U. S. A., the Secretary of Section H, already announced by the PERMANENT SECRETARY, creates a vacancy in that office.

4. Sections E and H are directed by the COUNCIL to fill the vacancies in the Secretaryship of each.

5. The COUNCIL directs that the following communications be read: —

Editorial Rooms of The Iron Age, New York, April 16, 1896.

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE, SALEM, MASS.

GENTLEMEN, — At the request of Professor A. v. KERPELY, I take pleasure in forwarding to you the enclosed invitation to attend the Mining and Geological Congress at Budapest.

Yours truly,

C. KIRCHHOF,

Editor THE IRON AGE.

(6. *Bulyovszky-utcza*) *Budapest, February* 20, 1896.

TO THE MEMBERS OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE: —

The Metropolitan City and residence of the King of Hungary is preparing to solemnise this their millennium by a series of great festivities.

A thousand years have passed since our country has sprung into existence and has assured its liberty in the very heart of Europe.

After many hard struggles which often threatened our total annihilation, we have firmly held our ground, and are now going to extend, in an intellectual and ethical point of view, the construction of our public life.

We mountaineers and geologists will do our share in the demonstration by convoking our colleagues from abroad to debate with them on subjects of mutual scientific interest.

We have therefore decided to hold, on the 25th and 26th of September, 1896, a Mining and Geological Congress in connection with the Millennial National Exhibition, and we hope to welcome all those of our friends and colleagues who may choose to take part therein.

We presume that our National Exhibition alone will afford some interest to those not fully acquainted with the situation of our country, but we shall feel happy if our invitation will also result in inducing the participation in discussions.

It is proposed that on the days destined for the meetings of this Congress the rich Exhibition of Industry and Agriculture, as well as its most interesting historical features, shall be visited under professional guidance.

According to the number of foreign and home members, discussions will be opened in special sections, for which reason we have decided to constitute the following sections: (*a*) Geology, (*b*) Coal-Mining, (*c*) Metal-Mining, (*d*) Preparation of Metal Ores in a wet way, (*e*) Proceedings of extracting metal, (*f*) Iron-ore Mining and Metallurgy, (*g*) Rock-salt Mining, (*h*) Mintage, and (*i*) Mining Legislation.

Lectures as well as the discussions to be held can be made not only in Hungarian, but also in German, French, and English.

Notices of lectures to be given at latest until the 1st of April *a. c.*, and rough copies of the same to be sent to the undersigned Committee, the latest until the 1st of July *a. c.*, in order to give time to have them translated into other languages and to have them put into print.

After the closing of the Congress, excursions of two to three days' duration will be made into some of our most important coal mines, iron works, and interesting gold districts.

In the name of the Executive Committee, I have the honour of inviting you to partake in our Congress, and hope you will be largely represented by members who, by lectures and arguments on questions of national economical importance, will enliven our discussions and add to the success of this Congress.

Finally, I beg to observe that notice of participation can be registered at my office (Budapest VII. Bulyovszky-utcza 6) until the 1st of July *a. c.*, and that our Committee will also undertake to provide suitable lodgings for the members if required to do so.

We are, with great respect,

Truly yours,

A. v. KERPELY,
President, Executive Committee.

The Buffalo Library, Buffalo, N. Y., May 18, 1896.

PROF. F. W. PUTNAM,
SECRETARY AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE, SALEM, MASS.: —
DEAR SIR, —

Agreeably to a resolution adopted by the Board of Managers of the Buffalo Library, I beg to extend to your Association the privileges of the Library during the convention to be held in this city in August next.

Yours very truly,

JOSEPH L. HUNRICKER,
Corresponding Secretary.

6. Bliss Bros., photographers, request the members of the Association to assemble on the steps at the northwest corner of the High School on Tuesday, August 25, at 12:15 P. M.

7. The COUNCIL recommends that daily sessions be held from 10 to 12 A. M., and from 2 to 5 P. M., on Monday, Tuesday, Wednesday, Thursday, and Friday.

The recommendation was unanimously adopted.

8. The COUNCIL has arranged for the following lectures to be given complimentary to the citizens of Buffalo in the Chapel of the High School: —

Wednesday, 8 P. M. Dr. J. W. SPENCER on "Niagara as a Time Piece."

Thursday evening, 8 P. M. Mr. MERCER and Dr. COPE, on the "Results of Cave Explorations in the United States, and their bearing on the antiquity of Man."

9. The COUNCIL has authorized Sections F and G to hold a joint session on Wednesday afternoon at 2 o'clock.

10. The COUNCIL has elected seventy-one new Members; also three Associate Members for the present meeting, viz. VICTOR GUTZU, of Bucharest, Roumania; SEIRYU MINE, of Tokyo, Japan; and Miss MARY FOSTER, of London.

11. The COUNCIL has authorized special excursions offered to Sections E, F, and G.

A resolution offered by W. H. HALE, relative to the semi-centennial celebration of the founding of the Association, was referred to the COUNCIL.

After announcements by the Local Secretary, regarding railroad certificates, excursions, and receptions, the session adjourned.

EVENING SESSION, MONDAY, AUGUST 24.

The Association convened in the Chapel of the High School at 8 P. M. President COPE in the chair. The PRESIDENT introduced Prof. EDW. W. MORLEY, the Retiring President, who delivered an address upon "A completed chapter in the history of the atomic theory." [The address is printed in full elsewhere in this volume.]

After the address the Association adjourned to the rooms of the Buffalo Society of Natural Sciences, where an informal reception was held, affording members an opportunity to inspect the collections and rooms of the Society.

GENERAL SESSION, TUESDAY MORNING, AUGUST 25.

The Association was called to order at 10 A. M. by President COPE in the Chapel of the High School.

The GENERAL SECRETARY announced: —

1. The nomination by the COUNCIL of ALEXANDER MACFARLANE, of Austin, Texas, as a Vice-President of the Association and Chairman of Section A. The SECRETARY was directed to cast the ballot of the Association for the nominee, and he was declared duly elected.

2. The election by the COUNCIL of nineteen new Members.

The TREASURER read an abstract of his report, which is printed in full elsewhere in this volume.

After announcements of temporary interest by the GENERAL and LOCAL SECRETARIES, the Session adjourned.

A reception from 8 to 11 P. M. was tendered the Association by the Buffalo Society of Natural Sciences in the rooms of the Twentieth Century Club.

GENERAL SESSION, WEDNESDAY MORNING, AUGUST 26.

The Association met at 10 A. M. in the usual place, President COPE in the chair.

The GENERAL SECRETARY made the following announcements: —

1. The COUNCIL has elected seventeen new Members.

2. The COUNCIL directs the reading of the following communication, and commends the matter to the individual generosity of members, since the funds of the Association do not warrant any grant: —

Pasteur Monument Committee of the United States,
Cosmos Club, Washington, D. C.

It has been decided to erect in one of the squares of Paris a monument to the memory of M. Pasteur. Statues or busts will also, no doubt, be located at his birthplace and in other cities. The Paris committee has, however, wisely determined that the statue obtained through international effort shall be located at Paris, where it will be seen by the greatest number of his countrymen and also by the greatest number of his admirers from other lands. The Paris committee has for honorary members the President of the Republic and his Cabinet, together with about one hundred and sixty of the most prominent officials, scientists, and other distinguished citizens of France. The active members of the committee are: — J. Bertrand, *President*, member of the French Academy, Perpetual Secretary of the Academy of Sciences. J. Simon, *Vice-President*, member of the French Academy, Perpetual Secretary of the Academy of Moral and Political Science. Grancher, *Secretary*, member of the Academy of Medicine, Professor in the Faculty of Medicine. Bruardel, member of the Academy and of the Academy of Medicine, Dean of the Faculty of Medicine. A.

Christophle, Honorary Governor of the Credit Foncier, Deputy from l'Orme. Count Delaborde, Perpetual Secretary of the Academy of Fine Arts. Duclaux, member of the Academy of Science and of the Academy of Medicine. Magnin, Governor of the Bank of France, Vice-President of the Senate. Baron A. de Rothschild, banker. Roux, Assistant Director of the Pasteur Institute. Wallon, Perpetual Secretary of the Academy of Inscriptions and Belles-Lettres.

The Paris committee has kindly extended the opportunity to the people of the United States to assist in this tribute of appreciation and love, and has authorized the organization of the Pasteur Monument Committee of the United States.

The members of this committee gladly accept the privilege of organizing the subscription, and of receiving and transmitting the funds which are raised.

We believe it is unnecessary to urge any one to subscribe. The contributions of Pasteur to science and to the cause of humanity were so extraordinary, and are so well known and so thoroughly appreciated in America, that our people only need the opportunity in order to demonstrate their deep interest.

All can unite in honoring Pasteur. He was such an enthusiastic investigator, so simple, so modest, so lovable, and yet so earnest, so great, so successful, — his ideals were so high and his efforts to ameliorate the condition of humanity were so untiring, that we anticipate an enthusiastic response from the whole civilized world. The United States will vie with the foremost of nations in this tribute. Chemists, zoölogists, physicians, and all others interested in science, will wish to be represented. No one is expected to subscribe an amount so large that it will detract in the least from the pleasure of giving. A large number of small subscriptions freely contributed and showing the popular appreciation of this eminent Frenchman is what we most desire.

It is our purpose to do our work as largely as possible through societies or other organizations. We prefer to have each organization appoint one of its members as an associate member of this committee, with authorization to collect and forward the subscriptions. The amounts thus far subscribed by individuals vary from fifty (50) cents to ten (10) dollars. It is hoped that no one who is interested will hesitate to place his name upon the list because he cannot give the maximum amount.

Please let this receive your early attention, and in that way assist our committee, which must conduct correspondence with the societies of the entire country.

D. E. Salmon, *Chairman.*
E. A. de Schweinitz, *Secretary.*

The following communication received by the Council was referred to Section F for report: —

The Joint Commission of the Scientific Societies of Washington, D. C.
Office of the Secretary, May 5, 1896.

F. W. Putnam,

Permanent Secretary American Association for the Advancement of Science: —

Dear Sir: —

There is now pending before Congress legislation looking to the restriction, if not practical prohibition, of vivisection in the District of Columbia. This pernicious legislation, ostensibly aimed at abuses which do not exist here, would, as you know, do incalculable injury to original biological and medical research, and should it become law will undoubtedly be made the basis of similar demands upon State legislatures. The accompanying resolutions are sent you by order of the Executive Committee of the Joint Commission in the hope that your Society will take similar steps to prevent affirmative action by Congress.

A copy of all resolutions adopted should be sent to the President of the Senate, the Speaker of the House, and to Dr. E. A. de Schweinitz, Agricultural Department, Washington, D. C.

Respectfully,

J. Stanley Brown,
Secretary.

3. The following resolution, reported by Section F, has been approved by the Council and is recommended to the Association for adoption: —

The American Association for the Advancement of Science, at its annual

meeting held at Buffalo, August 24th to 28th, 1896, desires to present to the Congress of the United States, its protest against legislation on the subject of vivisection. The membership of this Association is composed of experts and authorities, and persons interested in different branches of Science, in all numbering nearly two thousand. These members come from all parts of the country, and represent many diverse interests.

Whereas: This Association was organized for the purpose of advancing science, of diffusing scientific information, and exciting wide-spread interest on the part of the public in scientific progress; therefore be it

Resolved: That this Association deprecates any legislation on the part of the Government which would tend in the slightest degree to discourage the advancement of science, more especially biological, chemical, and medical science, at this time, when greater results are promised than ever before in the history of the world. And

Whereas: The health and welfare of men and animals are vitally affected by the results of animal experiments, and such experiments have effected a saving of many millions of dollars in animal property, and are the basis of our knowledge of hygiene and preventive medicine, and in part of surgery; therefore be it

Resolved: That while deprecating cruelty and needless vivisection experiments in the public schools, this Association believes that those who are trained in biological research are the ones who are best able to decide as to the wisdom and utility of animal experimentation, and deems that the legislation contemplated by Senate Bill 1552 would be unwise, and would tend to retard the increase of knowledge of the means of mitigation of the sufferings of men and animals.

The resolutions were unanimously adopted.

The following communication relating to the creation of the office of Director in Chief of the scientific divisions of the United States Department of Agriculture was referred to a committee for report: —

The Joint Commission of the Scientific Societies of Washington, D. C.
Office of the Secretary, March 7.

PROF. F. W. PUTNAM,
PERM. SEC'Y A. A. A. S.

DEAR SIR, —

Acting in accordance with instructions from the Executive Committee of the Joint Commission of the Scientific Societies of Washington, I have the honor to transmit herewith a copy of a series of resolutions, adopted by the Commission, in the hope that your Society may find it agreeable to take such steps as it may deem proper to promote the passage of so worthy a measure.

Very respectfully,

J. STANLEY BROWN,
Secretary.

4. The following report and resolution, submitted by the committee, has been approved by the Council and recommended to the Association for adoption: —

Your Committee has carefully considered the communication from the Joint Commission referred to, and has consulted sundry other papers sent on from Washington by persons interested in the movment in question. That there has been in Washington a movement towards the creation of such an office is probably familiar to all the members of the Council. The Committee is informed

that a circular letter from the Secretary of Agriculture has been sent to many of the members of the Council, and an editorial in "Science" has probably familiarized others with the matter. The Department of Agriculture has further been in correspondence with many scientific organizations in the country which could be regularly reached, and all have expressed themselves as favoring the plan.

In brief, the plan is the outgrowth of the unsatisfactory condition of affairs which has existed in the Department of Agriculture for some years,— in fact, since the great development of its scientific work which has taken place within the last decade. The officer having immediate supervision of the scientific divisions is the Assistant Secretary of Agriculture. This office is filled by Presidential appointment for a term of four years, and it has been found by experience that it takes the person appointed to fill this office about one year to familiarize himself with the details of the work, and that no sooner does he become thoroughly acquainted with the conditions than his term of office expires and a new man is appointed. Further, there is no certainty that the appointee to fill the office of Assistant Secretary of Agriculture will, in every case, be a man of broad scientific opinions, and able to satisfactorily supervise the work of the scientific divisions.

The great necessity for the existence of an officer of broad attainments, whose term of office would not be limited, and who could act in an advisory and controlling manner, becomes at once apparent. There are at present in the Department two large bureaus, namely, the Weather Bureau, and the Bureau of Animal Industry, and eight divisions, engaged in purely scientific work. Of the two thousand men employed in the Agricultural Department, nine hundred and ninety-three are engaged chiefly in scientific and technical work. And of the $2,400,000 appropriated annually, $1,700,000 is appropriated for work of this class.

In view of the evident desirability of legislation in the direction indicated, an amendment to the appropriation bill was introduced in the United States Senate, May 13th, 1896, and was referred to the Committee on Agriculture and Forestry. It received a favorable report from the Committee, but no action was taken by the Senate on account of the approaching close of the session.

It is hoped that favorable action may be reached during the next session of Congress, and to this end it is proposed to submit to Congress the opinions of prominent individuals and scientific organizations. The proposition has been warmly approved by the following persons and organizations:—

President Gilman and the scientific faculty of Johns Hopkins University.

President Dwight and the scientific faculty of Yale.

Seventeen members of the scientific faculty of the University of Michigan.

President Eliot and Professor Shaler of Harvard.

Presidents Schurman, of Cornell; Low, of Columbia; Warren, of Boston; Walker, of the Massachusetts Institute of Technology; Hall, of Clark; Canfield, of Ohio; MacLean, of Nebraska; Chaplin, of Washington (St. Louis); and many other heads of colleges, directors of agricultural experiment stations, members of scientific faculties, various academies of science and scientific societies, the Joint Commission of the Scientific Societies of Washington, Mr. Theodore Roosevelt, and other gentlemen identified with the cause of Civil Service Reform.

In view, therefore, of the obvious good to the cause of science which will result from this proposed legislation, and in view of the practically unanimous indorsement which it has received from prominent educators and men of science throughout the country, and in further view of the fact, which is none the less true, although it has not been publicly mentioned, that this movement is in the direction of the co-ordination of scientific work under the general government, it seems to your Committee that the American Association for the Advancement of Science can unhesitatingly approve.

Your Committee, therefore, recommends that the Council recommend to the Association the adoption of the following resolution:

Resolved: That the American Association for the Advancement of Science heartily approves the proposition to create the office of Director in Chief of scientific bureaus and investigations in the Department of Agriculture, to be filled by a broadly educated and experienced scientific man; provided that such appointment shall be made only on the nomination of the National Academy of Sciences, the legally constituted adviser of the government in matters relating to Science.

The report and resolution were unanimously adopted.

After announcements by the Local Secretary the session adjourned.

EVENING SESSION, WEDNESDAY, AUGUST 26.

The Association met at 8 P. M. in the Chapel of the High School, with President COPE in the chair.

A public lecture, complimentary to the citizens of Buffalo, was delivered by Mr. J. W. SPENCER, on "Niagara as a time-piece," illustrated by lantern slides.

GENERAL SESSION, THURSDAY MORNING, AUGUST 27.

The Association met at 10 A. M. in the usual place, the President in the chair.

The GENERAL SECRETARY made the following announcements: —

1. Mr. J. BISHOP TINGLE, of Aberdeen, Scotland, has been elected by the COUNCIL an Associate Member.
2. Two new Members have been elected by the COUNCIL.
3. The COUNCIL has received the following letter: —

Iroquois Hotel, Buffalo, N. Y., August 26th, 1896.

Prof. F. W. PUTNAM: —

DEAR SIR, —

President COPE's appeal this morning for assistance to honor the late scientist PASTEUR met with no response, owing to our depleted treasury. It occurs to me to give cause for regret, as it might be construed as want of sympathy.

Enclosed please find check for the above appeal.

The letter contained a check for $100. (Applause.) It is hardly necessary to name the donor, for those who have been often at the meetings of the Asso-

ciation will have recognized already the generous hand of Mrs. ESTHER HERRMAN. (Great applause.)

In this connection, the COUNCIL has authorized the Treasurer to receive and transmit contributions to the Pasteur Monument Fund in the name of the Association.

4. The Committee to which was referred a communication on the metric system has submitted the following resolution, which has been approved by the COUNCIL, and is recommended to the Association for adoption.

Resolved: That A. A. A. S. is now, as it always has been, earnestly in favor of reform in weights and measures, and it urges upon the Congress of the United States the desirability of further legislation looking to the early adoption of the metric system.

The resolution was unanimously adopted.

5. The COUNCIL has adopted the following recommendation of Section C: —

First. That the officers of Section C and of the American Chemical Society be authorized to prepare together the programme for the next meeting; that the first two days of the meeting be officially the meeting of the American Chemical Society, allowing, however, opportunity for the organization of the Section and the Vice-President's address.

Second. That the courtesy of reading papers in Section C be extended to the members of the American Chemical Society, and that the same courtesy be extended to members of Section C by the American Chemical Society.

6. The following communication from Mr. STILES was referred to Section F: —

U. S. Department of Agriculture, Bureau of Animal Industry,
Washington, D. C., August 20, 1896.

PROF F. W. PUTNAM,

SEC'Y AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE, BUFFALO, N. Y.

DEAR SIR: —

At a meeting of the Third International Zoölogical Congress, held at Leyden in September, 1895, an international commission of five members was appointed to study all of the codes of zoölogical nomenclature proposed in various countries, to compare these codes with the present international code, and to report at the next International Congress in England, 1898, any recommendations and amendments to the International Code which the commission should think advisable; also to make an official translation of the code from the French into English and German.

The members of this commission are Dr. SCLATER, England; Dr. RAPHAEL BLANCHARD, France; Prof. VICTOR CARUS, Germany; Prof. JENTINK, Holland; Dr. STILES, United States.

Upon returning from the Congress to this country I immediately suggested to certain American zoölogists the advisability of the appointment of an American advisory board, to which I might submit for approval or disapproval all the propositions I intend to support in the meetings of the International Commission, and as the plan met with favor I have addressed certain scientific societies requesting of each the appointment of a representative upon this advisory board. In response to these requests the following gentlemen have thus far been appointed:

By the Smithsonian Institution, Dr. DALL.

By the Society of American Naturalists, Prof. COPE.

By the American Ornithologists' Union, Dr. ALLEN.

By the National Academy of Science, Prof. GILL.

By the Royal Society of Canada, Prof. RAMSAY WRIGHT.

In accordance with the general plan as set forth in this letter and in the enclosed clipping [from Science, 1895, pp. 665–6], I respectfully request that the American Association for the Advancement of Science appoint one of its zoölogical members as a representative upon this advisory board. In making this request, I agree that my vote upon any given proposition in the Interna-

tional Commission shall be governed by this advisory board, should the occasion arise that my personal opinion upon that proposition differs from the opinion of the advisory board.

Hoping that the Association will be willing to appoint the representative desired, I remain,

Very respectfully, yours,

CH. WARDELL STILES,

Zoölogist Bureau of Animal Industry and U. S. Government Delegate to the Third International Zoölogical Congress.

Section F recommended the appointment of Dr. A. S. PACKARD, of Providence, R. I., as a member of the American Advisory Board proposed by Dr. STILES, and the COUNCIL has made the appointment.

After announcements by the Local Secretary, the session adjourned.

EVENING SESSION, THURSDAY, AUGUST 27.

At 8 o'clock the Association met in the same place, President COPE in the chair. Owing to the absence of Mr. MERCER, the public lecture, complimentary to the citizens of Buffalo, was delivered by Prof. E. D. COPE, on "The results of cave explorations in the United States, and their bearing on the antiquity of man."

GENERAL SESSION, FRIDAY MORNING, AUGUST 28.

The Association met at 10:30 A. M., President COPE in the chair.

The GENERAL SECRETARY made the following announcements: —

1. The following communication to the COUNCIL from Section H was referred to the Section, with a request that the Section nominate the committee therein referred to.

Whereas: the influence which the environment of the New World has exerted upon the physical and mental development of the White Race, is a question of the utmost scientific and practical importance; and

Whereas: there appears to be no governmental or scientific bureau which is giving the study of this subject attention at the present time; therefore

Resolved: That the American Association for the Advancement of Science appoint a committee to organize an Ethnographic Investigation of the White Race in the United States, with special reference to the influence exerted upon it in its new surroundings, said committee to report annually to the Association.

Section H recommends the appointment of the following gentlemen to serve as a committee on Ethnographical Investigation of the White Race in America, in accordance with the action of the COUNCIL: D. G. BRINTON, J. McK. CATTELL, W. W. NEWELL, W J McGEE, and FRANZ BOAS.

These gentlemen have accordingly been appointed by the COUNCIL.

2. The COUNCIL has adopted the following resolution, received from Section E: —

Resolved: That Section E requests the COUNCIL of the American Association for the Advancement of Science to permit and authorize the officers of Section E to make such arrangements with the Geological Society of America for the

meeting of 1897 that the Geological Society may occupy a portion of the time usually assigned to the Section.

3. The COUNCIL, upon request of Section E, has appointed the following gentlemen as delegates to the International Geological Congress, to be held in St. Petersburg in 1897, and has authorized them to fill by a majority vote any vacancy which may occur: E. D. COPE, JAMES HALL, B. K. EMERSON, W. N. RICE, and C. D. WALCOTT.

4. The following report, from the Committee on *Standards of Measurement*, has been adopted by the COUNCIL, and the grant therein named made.

In view of the absence of any properly constructed and authenticated standards of electrical measurement prepared under the provisions of the law of 1894, this Committee recommends that it be authorized to construct such standards, and that, to pay, in part, the necessary expenses incident to this work, the sum of fifty dollars be placed at the disposal of the Committee, from current funds in the possession of the Treasurer; it being understood that any standards thus constructed or material acquired shall remain the property of the A. A. A. S. until otherwise disposed of by the COUNCIL.

5. The Committee on *Grants* has recommended, and the COUNCIL has made, the following grants:—

To WOODS HOLE BIOLOGICAL LABORATORY, $100.

To PROF. FRANCIS C. PHILLIPS, for INVESTIGATION OF PROPERTIES OF NATURAL GAS, $50.

To DR. L. A. BAUER, for INVESTIGATIONS IN TERRESTRIAL MAGNETISM IN CONNECTION WITH THE MAGNETIC SURVEY OF MARYLAND, $50.

6. The following report of a Committee appointed by the COUNCIL has been adopted:

Whereas: It is explicitly stated in Article 11 of the Constitution of the American Association for the Advancement of Science that the "Vice-Presidents shall be chairmen for their respective sections": and,

Whereas: It has grown to be the custom in the daily programmes to ignore the constitutional title "Chairman" in referring to the presiding officers of the sections, thus bringing about a certain misconception in the minds of those not familiar with the Constitution: therefore, be it

Resolved: That the COUNCIL instruct the PERMANENT SECRETARY, in preparing programmes and other matter relating to the Association, to use the term Vice-President in expressing the relation of the presiding officer of any section to the Association, and the title Chairman in expressing his relation to his section. Where both relations are to be expressed, the term Vice-President should precede the name, and Chairman should follow. Where, moreover, it seems necessary to refer to those officers, as in the list of special committees of the Association (page 5 of the Constitution, etc.), they shall be termed Vice-Presidents for the sections, and not Vice-Presidents of the sections.

7. The COUNCIL has received the following report from the Library Committee, which it directs to be read for the information of members:—

June 20, 1896.

The Committee on the Library of the Association respectfully reports that, in accordance with the agreement entered into with the authorities of the University of Cincinnati, the Library was

packed and forwarded to Cincinnati early in the spring of the current year. As the new Science building of the University will not be completed until September, it has been necessary to postpone until then the arrangement, classification, and cataloguing of the collection. Proper provision has been made for all of these matters, so that in a few months the Library will be in the proper condition for consultation, either on the spot or by those at a distance.

Respectfully submitted,

ALFRED SPRINGER,
WM. L. DUDLEY,
T. H. NORTON,
A. W. BUTLER,
THOMAS FRENCH, JR.

8. In response to a request from the National Educational Association, the following Committee has been appointed by the COUNCIL to coöperate with a committee of that body in the consideration of the coördination and simplification of science requirements for entrance to college: R. S. TARR, H. S. CARHART, A. S. PACKARD, C. F. MABERY, and C. E. BESSEY.

9. The COUNCIL has elected one new Member, making a total for the present meeting of 110.

10. In accordance with the following proposal from Section H, the COUNCIL has elected HORATIO HALE, of Clinton, Ont., a Life Fellow of the Association.

Section H presents the following resolution adopted at the afternoon session: —

Whereas: HORATIO HALE, long an active member and at one time Vice-President of this Association, has made contributions to ethnology and philology entitling him to a place in the first rank of American anthropologists; and

Whereas: it seems fitting that Mr. HALE's long and arduous labors in behalf of science should be recognized by the A. A. A. S.; therefore,

Resolved: That Section H recommend to the COUNCIL that HORATIO HALE be made a Life Fellow of the Association.

11. The COUNCIL has elected the following Members to be Fellows of the Association: —

Austen, Prof. Peter T., 99 Livingston St., Brooklyn, N. Y. (44). **C**
Bacon, Chas. A., Beloit, Wis. (36). **A**
Barnes, David Leonard, A. M., Suite 1750, Monadnock Building, Chicago, Ill. (43). **D**
Barnum, Miss Charlotte C., 144 Humphrey St., New Haven, Conn. (36). **A**
Bigelow, Willard Dell, Chem. Div., Dept. of Agric., Washington, D. C. (44). **C**
Blair, Andrew A., 406 Locust St., Philadelphia, Pa. (44). **C**
Bleile, Albert M., M. D., 342 S. Fourth St., Columbus, Ohio (37). **F**
Boyé, Martin H., M. D., Coopersburg, Lehigh Co., Pa. (1). **C**
Boynton, Prof. C. Smith, 69 North Prospect St., Burlington, Vt. (44). **C**
Bromwell, Wm., Port Deposit, Md. (40). **C**
Bull, Prof. Storm, Madison, Wis. (44). **D**
Campbell, Prof. Edw. D., Ann Arbor, Mich. (44). **C**
Cattell, Prof. James McKeen, Columbia College, New York, N. Y. (44). **BFHI**
Chalmot, G. de, Spray, N. C. (44). **C**
Chase, Frederick L., Yale Univ. Observ., New Haven, Conn. (43). **A**
Cochran, C. B., Food Inspector to State Board of Agric., 514 South High St., West Chester, Chester Co., Pa. (43). **C**

Collins, William H., Haverford College, Haverford, Pa. (41). **A**
Dains, Frank Burnett, Wesleyan Univ., Middletown, Conn. (41). **C**
Dana, James Jackson, Lt. Col. and Brevet Brig. Gen. U. S. Army, "Cosmos Club," 1520 H St., N. W., Washington D. C. (40).
Daniells, Prof. William W., Prof. Chem , Univ. of Wis., Madison, Wis. (42). **C**
Davis, C. H., Commander U. S. Navy, Chief Intelligence Officer, Navy Department, Washington, D. C. (40).
DIXWELL, EPES S., Cambridge, Mass. (1). **H F** (Founder.)
DuPont, Francis G., Wilmington, Del. (33). **A B D**
Earle, F. S., Prof. Biol., Ala. Polytechnic Institute, Auburn, Ala. (39). **G**
Eastman, Charles Rochester, Mus. Comp. Zoölogy, Cambridge, Mass. (41). **E**
Eichelberger, William Snyder, Ph. D., Wesleyan Univ., Middletown, Conn. (41). **A**
Ewell, Ervin E., Dept. of Agric., Chem. Div., Washington, D. C. (40). **C**
Ferry, Ervin S., Instructor in Physics, Univ. of Wis., Madison, Wis. (41).
Flather, Prof. John J., 160 South St., La Fayette, Ind. (44). **D**
Frankforter, Prof. Geo. B., Univ. of Minnesota, Minneapolis, Minn. (43). **C**
Gill, Augustus Herman, Mass. Inst. Technology, Back Bay, Boston, Mass. (44). **C**
Goss, Prof. Wm. F. M., La Fayette, Ind. (39). **D**
Greene, Prof. Edward Lee, Prof. Botany, Catholic Univ., Washington, D. C. (42). **G**
Gudeman, Edward, Ph. D., care Amer. Glucose Co., Buffalo, N. Y. (40). **C**
Hall, Arthur G., 63½ S. Division St., Ann Arbor, Mich. (41). **A B**
Hallock, Albert P., Ph.D., 440 First Ave., New York, N. Y. (31). **C**
Halsted, Prof. George Bruce, Austin, Texas (43).
Harrington, Prof. Mark W., Pres. University of Washington, Seattle, Wash. (40). **B**
Harris, Prof. E. P., Amherst College, Amherst, Mass. (44).
Haskell, Eugene E., U. S. Engineer Office, Sault Ste. Marie, Mich. (39). **A B D**
Hayes, Charles Willard, U. S. Geol. Survey, Washington, D. C. (41). **E**
Hedrick, Henry B., A.B., Nautical Almanac Office, Washington, D. C. (40).
Hillyer, Homer W., Ph. D., Univ. of Wis., Madison, Wis. (42). **C**
Hodgkins, Prof. H. L., Columbian University, Washington, D. C. (40). **A B**
Holland, Rev. W. J., D. D., Ph. D., Pittsburg, Pa. (37). **F**
HUBBARD, Prof. OLIVER PAYSON, 65 W. 19th St., New York, N. Y. (1). (Founder.)
Humphrey, James Ellis, Johns Hopkins Univ., Baltimore, Md. (44). **G**
Hunter, Andrew Frederick, Barrie, Ont., Can. (38). **B H I**
Kober, Geo. Martin, M. D., 1819 Q St., N. W., Washington, D. C. (40). **H**
Lambert, Preston A., 422 Walnut St., South Bethlehem, Pa. (41). **A**
Langenbeck, Karl, 27 Orchard St., Zanesville, Ohio (39). **C**
Leach, Miss Mary F., Mt. Holyoke College, Holyoke, Mass. (44). **C**
Lewis, John E., Ansonia, Conn. (40). **A B E**
Lord, Prof. H. C., Ohio State Univ., Columbus, Ohio (44). **A**
Lowell, Percival, 53 State St., Boston, Mass. (36). **A**
Lyford, Edwin F., Springfield, Mass. (33). **B C H**
McClintock, Emory, Morristown, N. J. (43).
Markley, Joseph L., Ph. D., 50 Thompson St., Ann Arbor, Mich. (40).

Moulton, Prof. Chas. W., Poughkeepsie, N. Y. (44). **C**
Nardroff, Ernest R. von, 360a Tompkins Ave., Brooklyn, N. Y. (44). **B**
Newcombe, Frederick Chas., 51 E. Liberty St., Ann Arbor, Mich. (43). **G**
Noyes, Miss Mary C., Ph. D., Lake Erie Seminary, Painesville, Ohio (43).
Olds, Prof. George D., Amherst, Mass. (38). **A**
Palache, Charles, Instr. in Min. and Petrog., Harv. Univ., Cambridge, Mass. (44). **E**
Parsons, Prof. C. Lathrop, Durham, N. H. (41).
Patterson, Geo. W., Jr., Ann Arbor, Mich. (44).
Patton, Horace B, Golden, Col. (37). **E**
Peale, Albert C., M. D., U. S. Geol. Survey, Washington, D. C. (36). **E**
Perry, Arthur C., 226 Halsey St., Brooklyn, N. Y. (43). **A B**
Pupin, Dr. M. I., Columbia College, New York, N. Y. (44). **B**
Raymond, Prof. Wm. G., Rensselaer Polytechnic Inst., Troy, N. Y. (44). **D**
Rotch, A. Lawrence, Readville, Mass. (39).
Seymour, Paul Henry, care Walter W. Seymour, 7030 Stewart Ave., Chicago, Ill. (44). **C**
Shaw, Professor James Byrnie, 1030 Grove St., Jacksonville, Ill. (43). **A**
Smith, Harlan I., Amer. Museum Nat. Hist., Central Park, New York, N. Y. (41). **H**
Speyers, Clarence L., Rutgers College, New Brunswick, N. J. (36). **C**
Squibb, Edward R., M. D., 152 Columbia Heights, Brooklyn, N. Y. (43). **C**
Talbot, Henry P., Mass. Inst. Tech., Back Bay, Boston, Mass. (44). **C**
Thurston, R. C. Ballard, Louisville, Ky. (36). **E**
Trenholm, Hon. W. L., Pres. Amer. Surety Co., 160 Broadway, New York, N. Y. (35).
Ward, Samuel B., M. D., Albany, N. Y. (29). **F C A**
Whitfield, J. Edward, 406 Locust St., Philadelphia, Pa. (44). **C**
Woodman, Dr. Durand, 80 Beaver St., New York, N. Y. (41).

12. The COUNCIL nominates as Honorary Fellow WOLCOTT GIBBS, Professor Emeritus, Harvard University, of Newport, R. I.

The SECRETARY was unanimously directed to cast the ballot of the Association for Professor GIBBS, and he was declared elected an Honorary Fellow.

13. The COUNCIL has appointed as AUDITORS for 1897 EMORY J. MCCLINTOCK and B. A. GOULD.

14. The NOMINATING COMMITTEE recommends that the following be elected officers of the Association for the next meeting: —

President.

WOLCOTT GIBBS, of Newport, R. I.

Vice-Presidents and Chairmen of Sections.

A. **Mathematics and Astronomy.** — W. W. BEMAN, of Ann Arbor, Mich.
B. **Physics.** — CARL BARUS, of Providence, R. I.
C. **Chemistry.** — W. P. MASON, of Troy, N. Y.
D. **Mechanical Science and Engineering.** — JOHN GALBRAITH, of Toronto, Canada.
E. **Geology and Geography.** — I. C. WHITE, of Morgantown, W. Va.

F. **Zoology.** — G. Brown Goode, of Washington, D. C.
G. **Botany.** — George F. Atkinson, of Ithaca, N. Y.
H. **Anthropology.** — W J McGee, of Washington, D. C.
I. **Social and Economic Science.** — Richard T. Colburn, of Elizabeth, N. J.

Permanent Secretary.

F. W. Putnam, of Cambridge, Mass. [Holds over.]

General Secretary.

Asaph Hall, Jr., of Ann Arbor, Mich.

Secretary of the Council.

D. S. Kellicott, of Columbus, Ohio.

Secretaries of the Sections.

A. **Mathematics and Astronomy.** — James McMahon, of Ithaca, N. Y.
B. **Physics.** — Frederick Bedell, of Ithaca, N. Y.
C. **Chemistry.** — P. C. Freer, of Ann Arbor, Mich.
D. **Mechanical Science and Engineering.** — John J. Flather, of La Fayette, Ind.
E. **Geology and Geography.** — C. H. Smyth, Jr., of Clinton, N. Y.
F. **Zoology.** — C. C. Nutting, of Iowa City, Iowa.
G. **Botany.** — F. C. Newcombe, of Ann Arbor, Mich.
H. **Anthropology.** — Harlan I. Smith, of New York, N. Y.
I. **Social and Economic Science.** — Archibald Blue, of Toronto, Can.

Treasurer.

R. S. Woodward, of New York, N. Y.

15. The following amendments to the Constitution have been approved and recommended by the Council, to be voted upon at the next meeting: —

To Article 9 add: "but all general officers shall serve until their successors are elected."

To Article 20 add: "The Council shall have power to adjourn a meeting when it shall deem the reasons for so doing sufficient; and when such adjournment shall take place before the regular election of officers, those in office shall continue to serve until such election occurs."

That Article 22 be amended by changing the name of Section I from Social and Economic Science to Sociology.

16. The following additional amendments were proposed by Professor Woodward: —

In Article 9, first and second lines, for "in General Session," read "by the Council."

In Article 17, line 5, strike out "nomination of," "and election," and "in General Session."

In Article 19, line 3, for "nominate" read "elect"; line 5, for "recommend" read "fix."

In Article 20, line 3, for "Association" read "Council."

Alter Articles 34 and 35 to form one Article, reading as follows: "The annual assessment for members and Fellows shall be five dollars. On the election of any member as a Fellow, an additional fee of two dollars shall be paid.

In Article 37, strike out the word "admission."

The amendments proposed by Prof. WOODWARD were referred to the COUNCIL.

17. Invitations for the meeting of 1897 have been received from Seattle, San Francisco, Indianapolis, Detroit, Denver, Minneapolis, Nashville, Columbus, and Toronto.

The NOMINATING COMMITTEE, having carefully considered all the conditions, recommends for adoption by the Association the following resolution:—

Resolved: That the meeting for 1897 be only a formal meeting; that it be held in the city of Toronto on August 17 of that year, and that the Association join in welcoming the B. A. A. S. to the continent of America.

After prolonged debate the following substitute was adopted:—

Resolved: That the meeting of the Association for 1897 be held as usual, but that the time and place be left to the discretion of the COUNCIL.

The PERMANENT SECRETARY was directed to return proper acknowledgments for the several invitations received.

After announcements by the LOCAL SECRETARY and Mr. GILBERT, the session adjourned.

EVENING SESSION; FRIDAY, AUGUST 28.

The final session of the Forty-fifth Meeting convened at 8.20 P. M. in the usual place, President COPE in the chair.

The GENERAL SECRETARY having left the city, the Acting General Secretary, ASAPH HALL, Jr., made the following announcements:—

1. The COUNCIL has voted, upon recommendation of the Committee upon the Policy of the Association,—

I. That the PERMANENT SECRETARY be instructed that in future the Proceedings of the Association shall be restricted to that part of the volume which would remain after eliminating (1) all papers read in sections and abstracts thereof, and (2) the list of deceased members except on their first announcement; but shall include such reports of committees as may be specially directed by the COUNCIL; also that, as far as possible, to each title shall be added where the paper is published in full.

II. That the PERMANENT SECRETARY be empowered to make such arrangements for the programme of the next meeting as may be found expedient.

III. That the SECTIONAL COMMITTEES should consider it as part of their duties to secure co-operation of scientific institutions and societies in their respective sections.

2. The COUNCIL has approved the following banks as depositories for the funds of the Association: Cambridge Savings Bank, Cambridge, Mass.; Institution for Savings of Merchants' Clerks, Metropolitan Savings Bank, Emigrant Industrial Savings Bank, and the Fifth Avenue Bank, all of New York, N. Y.

3. The COUNCIL has fixed the bond of the Treasurer at $100, with security to be approved by the PRESIDENT and PERMANENT SECRETARY.

4. The COUNCIL has selected Detroit as the place of the next meeting, beginning on the second Monday in August. The Association is to adjourn to Toronto for the purpose of joining in the welcome to the British Association for the Advancement of Science on August 18th.

The PERMANENT SECRETARY then gave the statistics of the meeting, and some reminiscences of the preceding meetings in Buffalo.

Mr. W. J. MCGEE offered the following resolution of thanks to the various bodies concerned in the entertainment of the Association: —

Whereas: This forty-fifth meeting of the A. A. A. S., and the fourth held in the beautiful city of the thunder-speaking river, has been of pleasant savor and will long be of sweet memory; and

Whereas: The pleasure and success of this memorable meeting are due to good offices of various persons and institutions of Buffalo; therefore

Resolved: That the Association hereby express grateful appreciation to these large-hearted and broad-minded men and women, and to the institutions they have made, as follows:

To His Honor Edgar B. Jewett, Mayor of Buffalo, and through him to the municipality and citizens, for a welcome to the hospitable gates of the city.

To the Buffalo Society of Natural Sciences, its officers and members, and especially to its President, Dr. Roswell Park, for initiating the movement for the meeting here, and for constant aid and numberless courtesies.

To the Hon. Henry P. Emerson, Superintendent of Education, for the use of the commodious high school building as a place of meeting.

To the Hon. T. Guilford Smith, President of the Buffalo Library Association for various courtesies, including the use of rooms in the Library building.

To the Local Committee, including the special committees, and particularly to Mr. Dorr, the local secretary, for their tireless efforts to make our stop pleasant and profitable.

To the Ladies' Reception Committee for many courtesies, and the special privilege of a visit to the attractive Twentieth Century Club.

To the Buffalo Club for hospitality and good cheer; and

To all and several of the good people of Buffalo, for their kindness is sweet unto our hearts. May they accept our thanks as we treasure their courtesies.

The resolutions were seconded warmly in brief addresses by Prof. FRANKLIN C. ROBINSON, Prof. B. K. EMERSON, and Rev. HORACE C. HOVEY, and were passed unanimously.

The Association then adjourned.

CHARLES R. BARNES,
General Secretary.

REPORT OF THE PERMANENT SECRETARY.

For the fourth time the citizens of Buffalo welcomed the Association to their rapidly growing city. 333 members and associates were in attendance from the following places: Buffalo, 13, and other parts of New York, 92; Ohio, 31; Massachusetts, 29; District of Columbia, 23; Pennsylvania, 22; Indiana, 13; Iowa, 12; Michigan, 11; Connecticut, 8; Canada, 8; Minnesota, 8; Wisconsin, 7; Illinois, 6; West Virginia, 4; Missouri, 4; Georgia, 3; Nebraska, 3; Louisiana, 3; New Hampshire, 3; Virginia, 3; Alabama, 3; South Carolina, 2; Kentucky, 2; Maine, 2; Utah, 2; Maryland, 2; North Carolina, 2; California, 2 Kansas, 1; Missouri, 1; South Dakota, 1; Mississippi, 1; Tennessee, 1; Roumania, 1; Japan, 1.

During the meeting there were given the Presidential Address, and the addresses of eight Vice-Presidents. Public lectures complimentary to the citizens of Buffalo were given on two evenings of the week. 270 papers were presented before the sections as follows:* A, 12; B, 32; C, 53; D, 18; E, 42; F, 23; G, 44; H, 33; I, 13.

Several important changes in the Constitution were proposed (see Report ot General Secretary, pages 256, 257) to which the attention of members is especially called. While many of these proposed changes are radical in their character, there is no doubt that some of them are progressive, and if adopted will lead to a change in the policy of the Association which may bring it more in touch with the scientific spirit of the times. It is important, however, that every member should carefully consider these propositions, which will be voted on at the meeting of 1897. Attention is also especially called to the vote of the Council (see Report of General Secretary, page 257) by which the present volume of Proceedings contains the titles only of the papers read before the Sections. Further changes in the character of future volumes have been suggested.

In compliance with the request of Sections C and E, it was agreed by the Council that the general plan for the meeting of 1897 should be as follows. Each Section of the Association is authorized to unite with such affiliated societies as deemed desirable, with the understanding that such united meetings shall not interfere with the General Session nor with the delivery of the presidential Address on the first day of the meeting, nor with the organization of the Sections and the Addresses of the Vice-Presidents. With these provisions, two days of the week may be given to the Affiliated Societies, and the remainder of the week to the Meetings of the Sections. The members of the Association may take part in the meetings of the affiliated societies, and the members of the

societies are invited to take part in the meetings of the Sections. The object of this arrangement is to bring about a closer union and co-operation between the affiliated societies and the Association, and to concentrate the work of all within one week.

During the recent Christmas holidays Section H held an informal meeting in New York, and a proposition will be made at the next meeting in relation to authorizing any section to hold a winter meeting at such time and place as its officers may designate; such meetings to be managed entirely by the officers of the sections, and the Association as a body not to be in any way involved by any act of a section. It is thought that such meetings in the winter will have a tendency to concentrate the work of scientists in the several departments and to do away with the organization of special societies which have already become so numerous as to divert the labors of scientists into various channels, whereas unity, it is thought, would better accomplish their aims.

The plan of issuing a general programme for each section some time before each meeting of the Association, which was inaugurated for the Buffalo Meeting, has so many advantages that it was decided to continue the plan. The Council therefore authorized the Permanent Secretary to make such arrangements for the programmes as may be found expedient. The vote requesting and authorizing the Sectional Committees to prepare preliminary programmes for the coming meeting continues in force, and the Permanent Secretary earnestly requests the several committees to begin this work at once. The full preliminary programme for the week, including the programme of such affiliated societies as will unite with the respective sections, should be issued by the middle of June. Delay on the part of the sectional committees in preparing the copy for the preliminary programmes for the Buffalo Meeting prevented the plan from acting with full force at that meeting; but now that the first step has been taken, it will be comparatively easy for the committees to accomplish the work this year.

All signs point to a successful meeting in Detroit, with a large gathering of members who will afterward be cordially received in Toronto, where they will join in welcoming the members of the British Association to America.

A most cordial invitation was again received by the Association from San Francisco to hold its next meeting in that city. Careful consideration was given to this matter by the Council and the Nominating Committee, but owing to the fact that the British Association is to meet in Toronto in 1897, it was considered undesirable for the American Association to hold a meeting so far away as the Pacific Coast. It is believed that an interchange of courtesies between the two associations is highly desirable, and would be expected on the part of each. For this reason the Council was empowered to designate the time and place of the meeting of 1897. At the closing session, the Council announced that it had voted to accept the invitation from Detroit, and that the forty-sixth meeting of the Association would be held in that city, beginning with the Council meeting on Saturday, August 7, and the opening General Session on Monday morning, August 9. It was also decided that at the close of the week the Association should adjourn to Toronto for the purpose of joining in the welcome to the British Association on August 18.

Invitations to hold the meetings of '97 and '98 were also received from

Indianapolis, Nashville, Columbus, St. Paul and Minneapolis, Denver, and Seattle. Owing to the reasons above stated, the thanks of the Association were voted to the several institutions and public bodies joining in these invitations, and the hope was expressed that they might be renewed in future years.

Of the 110 members elected since the Springfield Meeting and during the Buffalo Meeting, 2 have declined membership, 71 have perfected their membership, as have 5 who were elected at the Springfield Meeting, and 1 who was elected at the Brooklyn Meeting; 18 have paid their arrears and these have been restored to the roll; 1 more founder of the Association has been added to the list of fellows as a life fellow; 1 honorary fellow has been elected; making 97 names added to the roll since the Springfield volume was published.

From the Springfield list 24 names (including 3 founders of the Association, 1 honorary fellow, and 1 life fellow) have been transferred to the list of deceased members; 37 members and fellows have resigned; and 147 have been omitted for arrearages; making a deduction of 208 from the list.

57 members have been transferred to the roll of fellows (two of these are founders of the Association who were made life fellows).

The following is a comparative statement of the roll as printed in the Brooklyn and Springfield volumes, and in the present volume: —

	Brooklyn.	Springfield.	Buffalo.
Living patrons	2	2	2
Corresponding members	2	1	1
Members	1042	1115	991
Living honorary fellows	1	3	3
Fellows	755	792	805
	1802	1913	1802
Honorary life members (founders) included in above	8	8	6

The distribution of publications since the last report is as follows: —

Memoir No. 1: exchange, 1 copy.

Proceedings: Vols. 1–43: delivered to members, 271; sold, 13; exchanges, 93; duplicate copy to member, 1; presented, 3; = 381.

Bought, 2; received as donation, 2; = 4.

Vol. 44: delivered to members, 1376; to subscribers, 4; sold, 26; exchanges, 247; presented, 4; = 1657.

Subscription has been received for 1 copy of Vol. 45.

The following statements by the Treasurer and Permanent Secretary show the condition of the invested funds, and the receipts and expenditures. It will be noticed that the cash account of the Permanent Secretary, in accordance with the new arrangement of closing the year on December 31, covers the period from August 1 to the end of the year 1895, including the Springfield Meeting. Thus the Report for the year 1896, including the Buffalo Meeting, will be presented at the Detroit Meeting and will be printed in the next volume.

The year 1898 will bring the fiftieth anniversary of the Association. At a meeting of the Association of Geologists and Naturalists held in Boston in 1847

it was voted to extend the scope of the Association and to reorganize under the name of the American Association for the Advancement of Science, the first meeting of the new association to be held in Philadelphia in 1848. This meeting was duly held, and Professor William B. Rogers presided as President of the Association of Geologists and Naturalists until the Constitution of the new association was adopted, when he resigned the chair to Professor W. C. Redfield, the President-elect of the new association. Thus Boston and Philadelphia each have a special claim to the Jubilee Meeting of the Association. It is certainly befitting that special arrangements should be made for this occasion; and we have a right to expect that a large number of scientists from abroad would join in celebrating the semi-centennial anniversary of an Association which has beyond all question done its full part in giving "a stronger and more general impulse and more systematic direction to scientific research" in America.

F. W. Putnam,
Permanent Secretary.

December 31, 1896.

REPORT OF THE TREASURER.

In compliance with article 15 of the Constitution, I have the honor to submit the following report showing receipts, disbursements, and disposition of funds of the Association for the year ending June 30, 1896.

Receipts have come into the keeping of the Treasurer from three different sources, namely: first, from life membership commutations; secondly, from subscriptions to the General Fund of the Association; and, thirdly, from interest on funds of the Association deposited in savings banks. The amount received from life membership commutations was $300.00; the amount received from subscriptions to the General Fund was $302.00; and the amount received as interest was $199.39; making a total of receipts for the year of $801.39.

Disbursements, in accordance with the directions of the Council of the Association, were made as follows: grants for research for the year 1894–95, $400.00; grants for research for the year 1895–96, $200.00; and grant to the journal Science, $750.00; making a total of disbursements for the year of $1,350.00.

The excess of expenditures over receipts was, therefore, $548.61.

The details of receipts, disbursements, and disposition of funds are shown in the statement which follows.

THE TREASURER IN ACCOUNT WITH

THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

DR.

1896.			
June 30.	To balance from last account		$5,932.12
	To amount received from life membership commutations		300.00
	To amount received from subscriptions to General Fund		302.00
	To interest on funds deposited in savings banks as follows:		
	From Cambridge Savings Bank, Cambridge, Mass.	$10.42	
	From Emigrant Industrial Bank, New York	43.53	
	From Institution for Savings of Merchants' Clerks, New York	80.80	
	From Metropolitan Savings Bank, New York	64.64	
			199.39
	Total		$6,733.51

CR.

Sept. 16, 1895.	By cash paid Professor F. W. Putnam for research grants of the year 1894–95		$400.00
Sept. 26, 1895.	By cash paid Professor H. C. Bumpus as grant to Wood's Holl Biological Laboratory		100.00
Nov. 12, 1895.	By cash paid J. McK. Cattell, Editor of the journal SCIENCE		750.00
Dec. 6, 1895.	By cash paid Professor Wm. A. Rogers as grant for research		100.00
June 30, 1896.	By cash on deposit in banks as follows:		
	In Cambridge Savings Bank, Cambridge, Mass.	$306.34	
	In Emigrant Industrial Savings Bank, New York	1,318.53	
	In Institution for the Savings of Merchants' Clerks, New York	2,080.80	
	In Metropolitan Savings Bank, New York	1,664.64	
	In The Fifth Avenue Bank, New York	13.20	
			5,383.51
	Total		$6,733.51

R. S. WOODWARD, *Treasurer.*

NEW YORK, N. Y., June 30, 1896.

I have examined the foregoing account, and certify that it is correctly cast and properly vouched.

EMORY MCCLINTOCK, *Auditor.*

NEW YORK, August 20, 1896.

F. W. PUTNAM,

IN ACCOUNT WITH THE AMERICAN

From August 1st

Dr.			
To Balance from last account			$27 24
Admission fees, Springfield Meeting and previous		$555 00	
Associate Members, Springfield Meeting		96 00	
Fellowship fees		88 00	
678 Assessments, Springfield Meeting		2,084 00	
400 "	Brooklyn Meeting	1,200 00	
60 "	Meetings previous to Brooklyn	180 00	
13 "	for Buffalo Meeting	39 00	
			4,192 00
Publications sold and binding			75 37
Miscellaneous receipts			4 22
Life Membership commutation			50 00
			$4,348 83

I have examined this account, and

CAMBRIDGE, 1896, May 9.

PERMANENT SECRETARY,

ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

to December 31*st*, 1895.

		Cr.
By Publication: —		
On account of printing 2500 copies of Proceedings, Vol. 44, composition, presswork, and paper . .	$1,821 31	
Illustrations	89 31	
Extra copies, addresses and reports from the Vol. .	62 55	
Illustrations for Vol. 48	10 99	
Back volumes of Proceedings bound	55 39	
" " " purchased	43 75	
		$1,533 30
By Expenses of Springfield Meeting: —		
General expenses	223 54	
Printing 500 copies Constitution, List of Members, etc.	72 60	
Section C	69 25	
" D	4 60	
" F	85	
" I	19 80	
		390 64
By General Office Expenses: —		
Rent of office, 6 months to Dec. 31, 1895	54 00	
Printing circulars, cards, etc.	54 75	
Type writing	10 00	
Petty expenses	2 93	
Express	57 91	
Postage and Post Office box	151 51	
Telegrams	2 83	
		333 93
By Salaries: —		
Permanent Secretary to Dec. 31, 1895	520 83	
Assistant " " "	300 00	
Janitor	41 67	
		862 50
By addition to Research Fund, Life Member's Commutation, transferred to Treasurer		50 00
By balance to new account		1,178 46
		$4,348 83

certify that it is correctly cast, and properly vouched for.

B. A. GOULD, *Auditor.*

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PROCEEDINGS

OF

THE AMERICAN ASSOCIATION

FOR THE

ADVANCEMENT OF SCIENCE

FOR THE FORTY-FIFTH MEETING

HELD AT

BUFFALO, N. Y.

AUGUST, 1896.

SALEM:
PUBLISHED BY THE PERMANENT SECRETARY.
JANUARY, 1897.

PROCEEDINGS

OF THE

American Association for the Advancement of Science.

8vo, paper. With numerous illustrations.

Vol.	I.	Philadelphia	Meeting,	1848,	pages	156,	published	1849.
	II.	Cambridge	"	1849,	"	479,	"	1850.
	III.	Charleston	"	1850,	"	239,	"	1850.
	IV.	New Haven	"	1850,	"	449,	"	1851.
	V.	Cincinnati	"	1851,	"	287,	"	1851.
	VI.	Albany	"	1851,	"	480,	"	1852.
	VII.	Cleveland	"	1853,	"	312,	"	1856.
	VIII.	Washington	"	1854,	"	372,	"	1855.
	IX.	Providence	"	1855,	"	357,	"	1856.
	X.	2nd Albany	"	1856,	"	547,	"	1857.
	XI.	Montreal	"	1857,	"	447,	"	1858.
	XII.	Baltimore	"	1858,	"	376,	"	1859.
	XIII.	Springfield	"	1859,	"	444,	"	1860.
	XIV.	Newport	"	1860,	"	328,	"	1861.
	XV.	Buffalo	"	1866,	"	174,	"	1867.
	XVI.	Burlington	"	1867,	"	218,	"	1868.
	XVII.	Chicago	"	1868,	"	410,	"	1869.
	XVIII.	Salem	"	1869,	"	352,	"	1870.
	XIX.	Troy	"	1870,	"	427,	"	1871.
	XX.	Indianapolis	"	1871,	"	491,	"	1872.
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	XXII.	Portland	"	1873,	"	669,	"	1874.
	XXIII.	Hartford	"	1874,	"	378,	"	1875.
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	XXV.	2nd Buffalo	"	1876,	"	424,	"	1877.
	XXVI.	Nashville	"	1877,	"	456,	"	1878.
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	XXIX.	Boston	"	1880,	"	875,	"	1881.
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	XXXI.	2nd Montreal	"	1882,	"	743,	"	1883.
	XXXII.	Minneapolis	"	1883,	"	598,	"	1884.
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	XXXVII.	2nd Cleveland	"	1888,	"	536,	"	1889.
	XXXVIII.	Toronto	"	1889,	"	600,	"	1890.
	XXXIX.	2nd Indianapolis	"	1890,	"	597,	"	1891.
	XL.	2nd Washington	"	1891,	"	585,	"	1892.
	XLI.	Rochester	"	1892,	"	496,	"	1893.
	XLII.	Madison	"	1893,	"	500,	"	1894.
	XLIII.	Brooklyn	"	1894,	"	599,	"	1895.
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	XLV.	4th Buffalo	"	1896,	"	354,	"	1897.

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Address, O. A. WATSON, Assistant Secretary,
Salem, Mass.